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The Four Borders Project: Reliability Improvement and Power Transfer in South Asia

A Pre-feasibility Study

Nexant

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List of Acronyms

AC	Alternating Current
BOOT	Build-Own-Operate Transfer
BPDB	Bangladesh Power Development Board
CERC	Central Electricity Regulatory Commission
CIER	Commission of Regional Power Integration (South America)
DC	Direct Current
DPR	Detailed Project Report
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
GOI	Government of India
GWh	Gigawatt hours
HEP	Hydroelectric Power Plant
HVDC	High Voltage Direct Current
IPP	Independent Power Producers
IRR	Internal Rate of Return
MOU	Memorandum of Understanding
NEA	Nepal Electricity Authority (Nepal)
NPV	Net Present Value
NTPC	National Thermal Power Corporation of India
PGCB	Power Grid Corporation of Bangladesh
PGC IL	Power Grid Corporation of India, Ltd.
PDB	Power Development Board
PPA	Power Purchase Agreement
PTC	Power Trading Corporation of India
Rs.	Rupees (India)
SAARC	South Asian Association for Regional Cooperation
SADC	Southern African Development Community
SARI/Energy	South Asia Regional Initiative in Energy
SAPP	Southern Africa Power Pool
SAPTA	South Asia Preferential Treaty Agreement
SEB	State Energy Board (India)
TSO	Transmission System Operator
USAID	United States Agency for International Development
USEA	United States Energy Association

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Executive Summary

PURPOSE OF THIS STUDY

The purpose of this pre-feasibility study is to provide guidance to regional power sector stakeholders as well as governmental policy-makers as to the possibilities for interconnecting transmission systems of Bangladesh, Bhutan, India, and Nepal in what is referred to in the report as the "Four Borders Region."

This regional interconnection (the "Four Borders Project") could provide significant benefits to regional economies through closer cooperation on regional power transfer, enhanced system reliability, improved security and diversity of supply, increased economic efficiency in system operation, reduced environmental impacts, and lower costs to consumers. It also could help attract private sector investment to the regional power sector.

This study is intended to be the first step in bringing this project concept to reality. It is expected to serve as the basis for further discussion and analysis, which will result in the identification of additional issues and questions that need to be addressed if this project is to move from concept to actuality. Accordingly, this report identifies additional technical assistance that may be required to move the project to the next stage in the development process. The results of this pre-feasibility study could eventually form the basis for design and development of a specific cross-border project upon completion of a more detailed project feasibility report.

ASSESSMENT OF PROJECT OPTIONS

Three technically viable options for the interconnection that would provide for multilateral power exchange were analyzed. These would locate the interconnection in India at either the Siliguri (West Bengal) or Purnea (Bihar) substations without using land in the constrained "chicken-neck" region of northeastern India. These options are:

- **Option A:** Limited Power Transfer – based on a 132 kV system;
- **Option B:** Moderate Power Transfer with Accelerated Development – based on developing a 220 kV system in advance of the system developments in Nepal and Bangladesh; and
- **Option C:** Moderate Power Transfer with Phased Development – based on developing a 132 kV system initially, which would be upgraded to a 220 kV system in conjunction with power sector developments in Bangladesh and Nepal.

PRINCIPAL RESULTS

The results of this analysis include:

- **Option C,** which incorporates a phased approach to developing the proposed Four Borders Project, best serves as the basis for establishing regional power transfer and trade and is the preferred option.

- Transfer of surplus power available from hydropower plants in Nepal and Bhutan through this interconnection can help reduce power deficits in India and Bangladesh.

- Preliminary power flow analysis indicates that the proposed interconnection would improve system stability and reduce transmission system losses in the region by about 90 MW.
- The options assessed would permit the transfer of power from 50 MW up to approximately 500 MW.
- Investment requirements for these options would be minimal, ranging from approximately $9 million to $52 million.
- Estimated levelized transmission costs for the options range from 2.6 cents per kWh for power transfers of 50 MW to 0.2 cents per kWh for transfers of 500 MW.
- All of the options analyzed have positive rates of return, which increase significantly with the level of power transfer.
- The options reviewed in this report could be easily implemented within the 2005-2010 time period.
- All of the options have minimal environmental impacts, as they rely extensively on existing facilities.

RECOMMENDATIONS AND NEXT STEPS

To achieve these benefits and to make the proposed Four Borders Project a reality, it is recommended that a Working Group be established consisting of regional stakeholders representing India, Bangladesh, Bhutan, and Nepal to review the proposed project, serve as a liaison with energy ministries and other sector stakeholders, and develop and oversee an implementation strategy. Major elements of this strategy should include:

- Develop and execute an Inter-Governmental Memorandum of Understanding, which would establish principles for power trade and transfer among the countries to promote an integrated regional transmission system for the benefit of all parties.
- Develop and execute an Inter-Utility Memorandum of Understanding for regional transmission system operators that establishes the operating principles and rights and obligations of participants and the procedures for ensuring full cost recovery and equitable sharing of benefits;
- Prepare a detailed project report for the World Bank and the Asian Development Bank that meets all of the requirements for developing, financing, and implementing the proposed regional interconnection; and
- Establish an Environmental Assessment Team with representatives from Bangladesh, Bhutan, India and Nepal to address environmental and social issues associated with this project and coordinate with the Working Group.

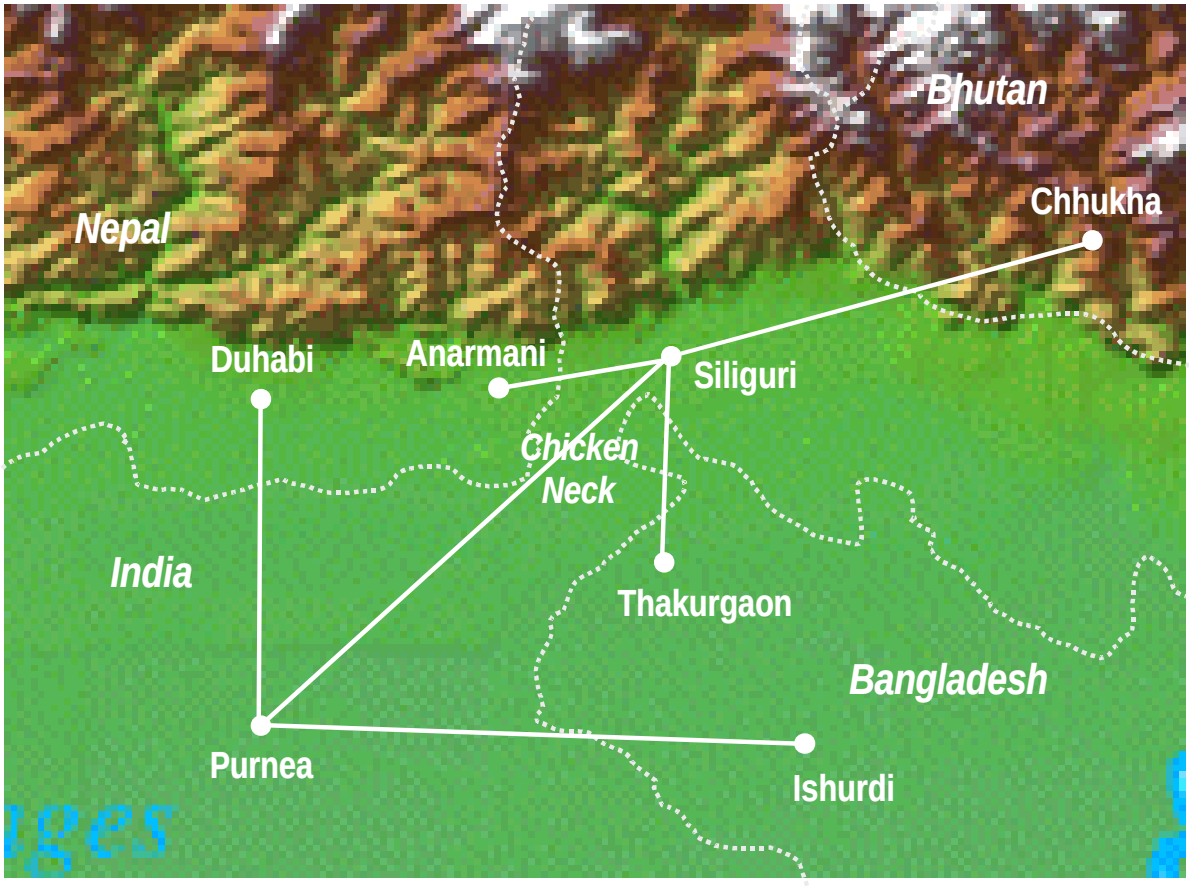
This implementation strategy could be supported by technical assistance provided by USAID under the SARI/Energy Project. Activities that could be provided under the SARI/Energy Project include:

- Review the regional energy supply/demand balance and confirm the amount and cost of power available for regional power transfer and trade under the recommended option;

- Validate the recommended interconnection option and perform a detailed integrated resource assessment to further quantify the costs and benefits;
- Identify and select favored options for establishing open transmission access, fair pricing and conditions of service for inclusion in a regional transmission services agreement;
- Review legal and regulatory requirements to support development of the proposed interconnection and provide assistance to draft any necessary changes/additions in rules, regulations, and laws;
- Provide assistance to establish a regulatory regime that would support development of the proposed regional interconnection by coordinating existing or proposed independent regulatory entities in each country; and
- Support development of an initial environmental impact assessment to collect data, assess impacts, and develop mitigation measures that would be implemented through an environmental management plan.

The details of the analysis, including technical and economic evaluations of options and basic data and assumptions are provided in the body of this report. A conceptual configuration for the proposed Four Borders Project is provided in the map below.

Geographic Configuration of the Interconnections



Section 1 Purpose, Background and Scope

The purpose of this pre-feasibility study is to provide guidance to participants in the South Asia power sector as well as governmental policy-makers as to the possibilities for interconnecting transmission systems in the region encompassing the northern area of India and adjacent areas of Nepal, Bangladesh, and Bhutan. Such an interconnection could provide potential benefits through closer cooperation on regional power transfer resulting in enhanced system reliability, improved security of supply through regional diversification, improved economic efficiency in system operation, reduced environmental impacts, and lower costs to consumers.

In this study to avoid confusion, the area where the four countries are geographically close is referred to as the "Four Borders Region." In some instances this region has also been referred to as the "chicken-neck" area; however, this designation is for a much more specific area in northeastern India as is discussed in Section 3. This designation has also been used by the Power Grid Corporation of India, Ltd. (PGCIL) with reference to specific project transmission expansion plans in the chicken-neck area for domestic purposes.

The focus of this pre-feasibility study is to assess the potential for developing multi-lateral power transfers by establishing a regional interconnection in the Four Borders area connecting Bhutan, Bangladesh, Nepal and India.

The focus of this study is to conduct a preliminary assessment of the potential to develop a regional power system interconnection in the Four Borders Region that could eventually form the basis for a specific project. This includes a review of existing and planned infrastructure and proposing alternative transmission system approaches, which could be implemented with minimal restrictions. The objectives of this pre-feasibility study are to define and frame the requirements and conditions needed to develop a regional interconnection combined with an initial estimate of associated benefits and costs. Three areas were emphasized: technical requirements, economic viability, and commercial and legal considerations.

Technical requirements – Based upon consideration of the existing grids in each country and plans for upgrades, alternative system configurations were defined, their technical viability was assessed, and the associated environmental consequences were considered. In developing these alternatives, consideration was given to existing and potential power transfer opportunities; projected power system supply and demand scenarios; capacity and compatibility of the grids; and load dispatch among the four countries.

Economic viability – Based on the technical requirements, the first order investment requirements and associated economics of the concept were assessed by estimating project returns and prospective transmission costs for each alternative. Other associated benefits and costs also were identified and defined.

Commercial/legal considerations – Given this technical and economic framework, the potential legal and commercial structures that would facilitate development, ownership, and operation of the proposed Four Borders Project were examined. Issues considered include:

- What are the recommended ownership and operational arrangements for structuring a regional grid project?
- What legal and regulatory steps are necessary to authorize electricity transfer and potentially power trade among the four countries?
- What additional policies, legal provisions, regulations, or protocols would be necessary to implement this project?

The objectives of this study are to define the conditions needed to develop a regional interconnection; present an initial estimate of associated costs and benefits; and identify issues that need further review and resolution.

Background

The Four Borders project concept is an outgrowth of workshops held under the SARI/Energy (South Asia Regional Initiative in Energy) program, which discussed issues related to regional power trade. These workshops were held in Kathmandu, Nepal in March 2001, and in Colombo, Sri Lanka in June 2001. This concept was further developed in a United States Energy Association (USEA) workshop sponsored by USAID for the South Asia Regional Energy Transmission Partnership, Executive Exchange Program held on April 23-25, 2001 in Dhaka, Bangladesh.

The participants in both the SARI/Energy program and the USEA program believed the concept of an interconnected grid presented some real possibilities in terms of a relatively easily implemented project. The rationale was that an interconnection of the electric grids of all of the countries in the Four Borders Region would provide opportunities to enhance system reliability and increase the ability to transfer power among these countries. Furthermore, as the countries are in the closest geographic proximity in the Four Borders Region, such an interconnected grid would have minimum investment requirements and would pose the fewest technical and environmental challenges. Thus, this study was conceived to provide an initial proof of concept.

Due to the close proximity of the countries in the Four Borders area, a regional electricity interconnection could be developed with minimal technical challenges and at minimum cost.

Currently, limited power transfer in the region takes place with India on a bilateral basis. Nepal exchanges power with India through isolated transmission lines, while Bhutan exchanges power through the main Indian grid. Bangladesh has no links to any country in the region, although various proposals to import power to India have been initiated by the National Thermal Power Corporation of India. These current power transfers are discussed in more detail in Section 2. Prospectively, Nepal, Bhutan, and Bangladesh are interested in the process of power transfer as a means of increasing system reliability, improving energy diversity through the increased availability of hydroelectric power, and increasing the

security of supply by diversifying supply sources. Although it is in the interest of these countries to develop new export markets by transferring power through a new regional interconnection, India too would benefit from this transmission link by earning wheeling charges for the power wheeled through the transmission system in this area and through improved system reliability. Moreover, the proposed interconnection is anticipated to help improve the stability of the regional power grid.

Approach

With this current situation as background, the approach taken in this initial assessment of the project is to consider the following:

- Identify and characterize the need for power transfer in the region based on current and future supply/demand conditions;
- Develop and characterize alternatives for a cross-border interconnection in terms of equipment and associated investment costs and assess the technical viability of alternatives with the objective of defining a specific project concept;
- Rank the alternatives based on the project evaluation criterion of internal rate of return and levelized investment costs;
- Address commercial/legal issues, which would facilitate development; and
- Identify the next steps required to further develop this project.

Based on this approach, the underlying premises for this assessment were that:

1. The interconnected grid must benefit all countries by allowing multilateral power transfers; and

2. The interconnection could be implemented relatively quickly with minimal technical, investment, and institutional requirements.

All countries involved in the interconnection would receive benefits. Non-technical issues involving cross-border agreements, financing, regulation, and commercial operation pose the greatest challenge

It was essential to examine a realistic timeframe under which such a project could materialize. The consensus was that, given the conditions and unmet domestic power needs of each country and the time needed to construct such an interconnection, it would be unrealistic to consider a project implementation timeframe earlier than five years.

It also was necessary to consider a development strategy for the project. Two strategies were considered: (1) a single-phase project, where the interconnection would be developed in a single step; and (2) a two-phase project, where the interconnection would be developed in two steps: phase one, with an initial low level of system transfer capability followed by phase two with a higher level of transfer capability. The first phase would focus on establishing a sound technical and operational basis for enhancing system reliability, resource diversity, and power transfer. The second phase would involve the longer-term

goal of creating a regional market with attendant power trade among the countries in the region, which would help improve operating efficiencies and reduce costs.

In discussions that took place in each country, stakeholders expressed the belief that technical issues should not present a significant barrier to the project; rather it was the non-technical issues such as cross-border agreements, commercial operation, and financing that appeared to pose the greater challenge. However, these concerns are not unique to the Four Borders concept. Globally interconnected grids are already in operation in Southern Africa and Northern Europe, and regional grids are proposed or under development in the Baltics, Balkans, and Central and South America. Thus, sufficient precedent exists that has proven that non-technical barriers can be resolved to mutual benefit. (See Appendix A for a review and analysis of regional interconnections in other parts of the world.)

A regional interconnection could be developed within about a 5-year period. A two-phase approach to prove the soundness of the concept, and then to capture regional benefits and reduce costs may be appropriate.

Section 2 Situation Review

In this section, the basis for increasing power transfer and trade among the Four Borders countries is addressed by examining the following factors:

- Providing an overview of the existing transmission, power transfer, generation, and demand situation in each country;
- Examining planned transmission system development in each country;
- Reviewing planned generation capacity and load requirements;
- Assessing power supply/demand in the Four Borders countries; and
- Identifying the potential for power transfer and trade.

As will be discussed in Section 3, the Siliguri substation in the Indian State of West Bengal and the Purnea substation in the Indian State of Bihar are the two alternative hubs that were considered for interconnecting the Four Borders countries. These two configurations are referenced in this overview.

2.1 CURRENT CONDITIONS

The design alternatives for interconnecting the grids of the Four Borders countries will be influenced by existing and planned transmission system developments in each country. Accordingly, this situation review begins with a survey of the transmission systems in each country.

2.1.1 Transmission Systems in the Region

2.1.1.1 Bangladesh Transmission System

The transmission system in Bangladesh is owned and operated primarily by the Bangladesh Power Development Board (PDB). The ownership and operating responsibility for the system will eventually be transferred to the Power Grid Corporation of Bangladesh (PGCB). Currently, PGCB owns and operates about 20% of the total transmission grid. All new transmission lines are to be owned and operated by PGCB. There is no private sector participation in the transmission sector, although there is private sector participation in the generation sector through IPPs.

The Bangladesh transmission system consists of an integrated network of 132 kV and 230 kV lines covering the main load centers of the country. Existing double circuit 230 kV lines interconnect Bheramara and Ishurdi in the west with Ghorasal (Dhaka area) and Ashuganj at the center of the country. Double circuit 230 kV lines also interconnect Ashuganj and Hathazari and Rauzan (Chittagong area) in southeast Bangladesh. In addition, a double circuit 230 kV ring circumscribes the capital city of Dhaka.

An extensive network of 132 kV lines covers the majority of the country. Thakurgaon substation is the northernmost point, about 90 km from the Siliguri substation in West Bengal, India. For the Siliguri substation as the option for the Four Borders hub, Thakurgaon would be the nearest interconnecting point in Bangladesh.

A number of transmission lines are under construction in Bangladesh. The major lines are the double circuit 230 kV Comilla-Meghnaghat-Haripur-Rampura lines. These lines will be used to evacuate power from Meghnaghat Power Station to the national grid. The lines consist of a 60 km Comilla-Meghnaghat segment, 12 km Meghnaghat-Haripur segment, and a 10 km Meghnaghat-Hasnabad segment.

2.1.1.2 Bhutan's Transmission System

In Bhutan, ownership and operation of the transmission grid, as well as, generation and distribution are the responsibility of the Department of Power in the Ministry of Trade and Industry. At this time there is no private sector participation in any segment of the Bhutan power sector.

Bhutan's national transmission system is at an early stage of development. The country presently does not have a contiguous national grid interconnecting the load centers of the country. However, the central and the eastern regions of the country are interconnected with tie lines, while the western part of the country remains essentially separated from the rest of the country. The transmission system of Bhutan is dominated by 132 kV and 66 kV lines connecting the major power stations. The majority of the smaller power stations are connected by 33 kV lines.

Three circuits of 220 kV lines are used to export power from the Chhukha power plant to India. One of these circuits and another 220 kV line are also available for power transmission within the country.

India's 220 kV grid in the Eastern region runs parallel to the southern border of Bhutan. This grid connects the Rangia substation in the State of Assam and the Siliguri substation in the State of West Bengal. Currently, Bhutan is connected to this Indian grid at three locations: (1) Samdrup Jongkhar in Bhutan with Rangia in Assam via a single circuit 33 kV line, (2) Gelephug in Bhutan with Bongaigaon in Assam via a single circuit 132 kV line, and (3) Chhukha in Bhutan with Birpara in West Bengal via a triple circuit 220 kV line.

Bhutan is expanding its transmission system to support an increase in power exports. These new facilities could be used for the proposed Four Borders interconnection.

A double circuit 400 kV transmission line connecting the 1,020 MW Tala Hydroelectric Plant (HEP) in Bhutan and Siliguri in the State of West Bengal in India is being developed. The line will be able to evacuate up to 1,000 MW of power from the Tala HEP.

2.1.1.3 Nepal's Transmission System

Electric generation, transmission, and distribution in Nepal are owned and operated by the Nepal Electricity Authority (NEA), although IPPs also provide some generation. NEA is solely responsible for the planning and development of the transmission system. There is no private sector participation in the main grid.

The transmission system in Nepal is dominated by an east-west 132 kV grid running from the Anarmani substation in the east to the Mahendranagar substation in the west. All major hydroelectric and thermal power stations are connected to this grid. Except for two sections,

the entire east-west grid in made up of double circuit towers, which are currently strung with conductors on one circuit only. One of the exceptions is the Bardghat-Bharatpur-Hetauda section, and the other is the Duhabi-Anarmani section. These two sections are of single circuit construction. Two major substations in the eastern part of the country on the 132 kV grid are Duhabi and Anarmani. Of these two, the Anarmani substation is closer to the Siliguri substation, about 50 km, while the Duhabi substation is closer to the Purnea substation, about 95 km.

About 460 circuit km of transmission lines are under construction to link the four hydroelectric plants currently being built. These lines include the 150 circuit km Hetauda-Bardghat 220 kV line and the 174 circuit km Hetauda-Dhalkebar and the Butwal-Bardghat 132 kV lines. These lines are expected to be commissioned between the years 2002 and 2005.

In addition to the above, three 132 kV transmission lines are expected to be commissioned to transfer power with India. These lines will interconnect: (1) Butwal (Nepal) and Anandnagar (Uttar Pradesh, India), (2) Birgunj (Nepal) and Motihari (Bihar, India), and (3) Dhalkebar (Nepal) and Sitamadhi (Bihar, India). The transmission lines between Nepal and India are not connected to the main Nepal grid. As a result, they operate in radial and isolated mode.

Nepal's transmission system also is being upgraded to support power exports. An interconnection in the Four Borders area could expand export opportunities.

2.1.1.4 India's Transmission System

India's power/transmission system is divided into five distinct regions – Northern, Western, Eastern, Southern, and Northeast. With the exception of the Eastern and Northeast Regions, all other regions are currently operating independently. Synchronous alternating current (AC) interconnections currently do not exist between these regions. In contrast, the Eastern and the Northeast are connected through synchronized AC links.

The existing operational and planned inter-regional links over the next five years are listed below.

Existing inter-regional links:

- **HVDC Links:**
  - West to North with transfer capability of 500 MW
  - West to South with transfer capability of 1,000 MW
  - East to South with transfer capability of 500 MW
- **AC Links:**
  - West to East with transfer capacity of 450 MW
  - East to South with transfer capacity of 200 MW
  - West to South with transfer capacity of 300 MW

- North to East with transfer capacity of 200 MW
- West to North with transfer capacity 200 MW
- East to Northeast with transfer capacity of 1,000 MW

The total existing inter-regional transfer capacity is 4,350 MW. By the year 2002 the cumulative inter-regional transfer capacity is expected to be about 4,850 MW.

Planned inter-regional links in next five years (10th Five-Year Plan ending in 2007):

- **HVDC Links:**
  - East to North with transfer capacity of 3,000 MW
  - East to South with transfer capacity of 2,000 MW
- **AC Links:**
  - East to West with transfer capacity of 2,000 MW
  - East to North with transfer capacity of 2,000 MW

India's total transmission lines under operation include:

- 3,136 circuit km HVDC
- 42,000 circuit km 400 kV
- 212,000 circuit km 220/132 kV

Currently 400 kV is the backbone of India's transmission system. In the Eastern region, a double circuit 400 kV line is under construction connecting Tala HEP in Bhutan and Siliguri substation in India. Another double circuit 400 kV line is also under construction connecting Siliguri with Purnea in the State of Bihar. These lines will evacuate up to 1,000 MW from the Tala HEP for transfer to the Indian grid.

In the Eastern region, 220 kV is the primary transmission system linking Bongaigaon (Assam), Siliguri (West Bengal), and Purnea (Bihar). This link would provide the major power transfer route between India and the other Four Borders countries.

India's transmission system is being upgraded to interconnect its five regional grids and to increase power imports. India's transmission facilities in the Four Borders region could be used to support the proposed regional interconnection, which can be designed to avoid increased congestion in the "chicken neck" area.

Power Grid Corporation of India Ltd. is designated by the GOI as the Central Transmission Utility and is responsible for the development and operation of the interstate grid. Power Grid Corporation is currently seeking private sector participation in the development of the national grid.

2.1.2 Transmission System in the Four Borders Region

The transmission line options reviewed for this pre-feasibility study (see Section 3.1) would not pass through the chicken-neck area. Also, they are not expected to have significant

impacts on the Siliguri or Purnea substations, which are the principle substations for power flowing through the Eastern Region. However, transmission lines for evacuation of power from the Northeastern region of India as well as from Sikkim and Bhutan would pass through the chicken neck area. This area is located in the Siliguri district of the State of West Bengal in India and between the borders of Nepal and Bangladesh. The area narrows down to a mere 22 km over a distance of 18 km. According to India's power development plan, approximately 30,000 MW of power would be required to be evacuated through this area within the next ten to fifteen years.

There is an acute land shortage of establishing rights of way in the chicken-neck area. The availability of land for this transmission corridor is limited due to the requirement of space for other infrastructure facilities such as roads, oil and gas pipelines, and communication links. At present, one 220 kV and one 400 kV (under construction for evacuating up to 1,000 MW from the Tala project) lines cross this area connecting the Northeast region and Sikkim and Bhutan with the Eastern region. Power from Sikkim is pooled to the Siliguri substation through a 220 kV line.

2.1.2.1 Bangladesh Power Generation and Load

Bangladesh has an installed power generating capacity of 3,770 MW although available capacity is significantly less than this, which limits the ability to meet peak demand of approximately 2,900 MW. Consumption is approximately 11,000 GWh. Figure 2-1 shows demand in the various geographic areas of Bangladesh.

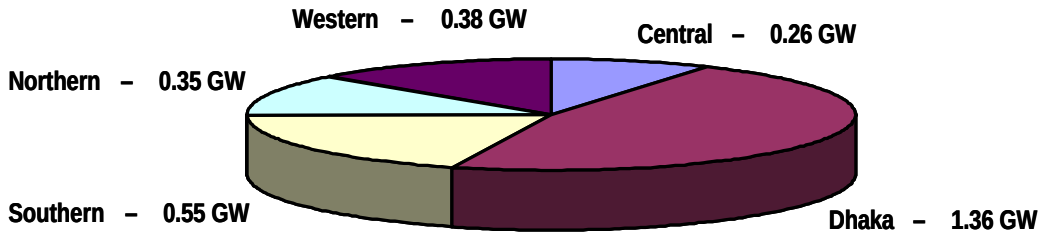


Figure 2-1: Regional Demand in Bangladesh (Total Demand 2,900 MW)

The Dhaka, Central and Southern regions are east of the Jamuna River. The Dhaka region constitutes about half of the entire Bangladesh electricity market with the other two regions making up about 25%. The remaining 25% of the market is in the Western and Northern regions, west of the Jamuna River. Economic and gas sector development has been largely confined to the eastern part of Bangladesh, resulting in a widening economic disparity between the eastern and western parts of Bangladesh.

2.1.2.2 Bhutan Power Generation and Load

The power generating capacity of Bhutan is relatively small compared to the neighboring countries. It has an installed capacity of 355 MW, of which 344 MW is from hydropower and 11 MW from diesel. Electricity demand is approximately 90 MW at peak. Bhutan generates about 2,130 GWh annually of which approximately 530 GWh is consumed internally and 1,600 GWh is exported per year. Bhutan also imports a small amount of energy, about 27 GWh from India to serve demand located in isolated areas not connected to the Bhutan grid.

Four hydroelectric power plants with a combined capacity of 1,140.8 MW are under construction and are expected to be commissioned by 2004 (see Table 2-1).

Table 2-1: Hydroelectric Projects under Construction in Bhutan

	Hydroelectric Project	Capacity MW	Expected Year of Commissioning
1	Tala	1,020	2004-05
2	Kurichhu HEP	60	2001-02
3	Basochhu-I HEP	22.2	2001-02
4	Basochhu-II HEP	38.6	2003-04
	Total	**1,140.8**	

2.1.2.3 Nepal's Power Generation and Load

Currently Nepal has an installed generating capacity of 433 MW consisting primarily of hydroelectric power, which totals 377 MW. The remaining 56 MW of capacity is from diesel and multifuel-based power plants. The system peak demand and annual energy consumption are 350 MW and 1,700 GWh, respectively.

Four hydroelectric power plants totaling 239 MW are under construction and are expected to be commissioned by 2004 (see Table 2-2).

Table 2-2: Hydroelectric Projects Under Construction in Nepal

	Hydroelectric Project	Capacity MW	Expected Year of Commissioning
1	Chilime	20	2002
2	Kali Gandaki	144	2002
3	Indrawati	5	2003
4	Middle Marsyangdi	70	2004
	Total	**239**	

2.1.2.4 India's Power Generation and Load

India's power generation capacity is by far the largest in the Four Borders Region. The Indian electricity market is segmented into five distinct regions. The total installed capacity of all the regions combined is approximately 100,000 MW and the total peak demand is approximately 75,000 MW. National consumption is over 485,000 GWh. The approximate relative demand of the regions is shown in Figure 2-2. The Eastern and Northeastern regions are shown together because they are interconnected and the Northeastern region has very low demand.

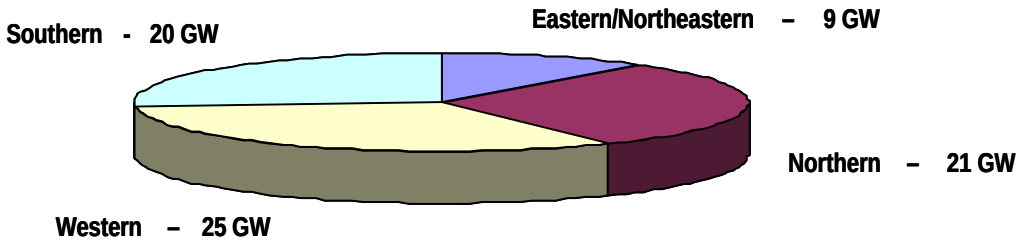


Figure 2-2: Regional Demand in India (Total Demand 75,000 MW)

2.1.3 Regional Power Transactions

Currently, there is no trading of power in the Four Borders region in the sense that one country can sell power to another at a market-based price. Power transactions are executed on the basis of exchange agreements and bilateral export agreements where the price has been set through negotiation. This section reviews the current power transactions among the four countries.

2.1.3.1 Power Transfer Between Bhutan and India

About 75% of Bhutan's electricity generation is exported to India. India has been purchasing power from Bhutan's Chhukha power plant at a price of 3.25 US cents per kWh. During the 1992-2000 period, India has purchased power at an average rate of 1,400 GWh per year. During the 1999-2000 fiscal year, exports amounted to 1,626 GWh. Bhutan also imported a small amount of electricity, about 27 GWh, from India. The majority of the Tala HEP output (approximately 1,000 MW) will be exported to India under a bilateral agreement. Bhutan does not directly transfer power to or from Nepal or Bangladesh

2.1.3.2 Power Transfer Between Nepal and India

The systematic power exchange between Nepal and India began in 1992 at an average level of 50 MW. During the year 2000, Nepal received 132 GWh of energy and 18 MW (minimum) of power from India under the Koshi and Tanakpur Treaties.

Currently, there are 19 different interconnections for power exchange with India. These include three 132 kV, ten 33 kV, and six 11 kV connections with the Indian States of Bihar and Uttar Pradesh. The other connections are at 66 kV and 33 kV. With all these and other planned interconnections in place, the level of power transfer between Nepal and India will reach 150 MW by the year 2005. Nepal does not currently transfer power to or from Bhutan or Bangladesh.

2.1.3.3 Power Transfer Between Bangladesh and India

Currently, there is no power exchange between Bangladesh and any of the other Four Borders countries. Bangladesh is surrounded by the Eastern region of India on the Western side and by the Northeastern region of India on the Eastern side and is in close proximity to Nepal on the Northwest side. Two 220 kV direct current (DC) interconnections are under consideration: Krishnanagar/ Farakka-Ishurdi between the Eastern Region of India and the Western Region of Bangladesh; and Shahjibazar-Kumarghat (initially to be operated at 132 kV level) between the Northeastern Region of India and the East Zone of Bangladesh. These interconnections could transfer power in the amount of about 150 MW.

2.2 SUPPLY/DEMAND SITUATION - 2010

For the purposes of this study, the time horizon of five to ten years is used to gauge the market potential for developing a regional interconnection. This was a period long enough to develop and construct a power system interconnection in the Four Borders Region. Set out below is a review of the prospective supply/demand situation in each of the Four Borders countries. This review is taken to estimate the available capacity that could be transferred through the proposed Four Borders interconnection. It should be pointed out that the supply projections are based on planned additions that may be delayed, while demand is usually based on trended estimates that do not address potential or unmet demand. Accordingly, the projected requirements in actuality may be greater than those discussed below.

2.2.1 Supply/Demand Situation in Bangladesh

The Bangladesh Power Development Board has projected peak demand for Bangladesh to be about 6,000 MW by 2007, based on the effect of certain power sector reforms, such as higher tariffs and lower losses. To supply this demand, approximately 2,400 MW of capacity additions are required from the end of 1998 through 2007. Some of this capacity is under construction (e.g., 420 MW at Ghorasal and Siddirganj, 120 MW of combustion turbines at Mymensing and Shajibaza, and an additional 100 MW from combustion turbine conversion to combined cycle at Haripur). Additional capacity is being phased in by IPPs, such as the 360 MW project at Haripur and the 450 MW project at Meghnaghat. However, most of this generation is located east of the Jamuna River. The only projects west of Jamuna are the rehabilitation of the Khulna 100 MW steam plant and a 100 MW gas-fired plant at Baghabari, which is still under negotiation.

Bangladesh is expected to have a significant need for power imports, particularly in the western part of the county, through at least 2007. Part of this need could be supplied by the Four Borders Project.

Even if all of the projects that are underway or under negotiation are completed, there will still be a serious deficit of capacity in Bangladesh. Figure 2-3 shows how this deficit is distributed between east and west. The larger capacity deficit is in the west (i.e., the western and northern electrical regions), where the cost of power production is the highest due to the reliance on liquid fuels and smaller plant size. Moreover, because of the power deficit in the east, the east-west interconnector will provide little relief even if capacity in the east is upgraded.

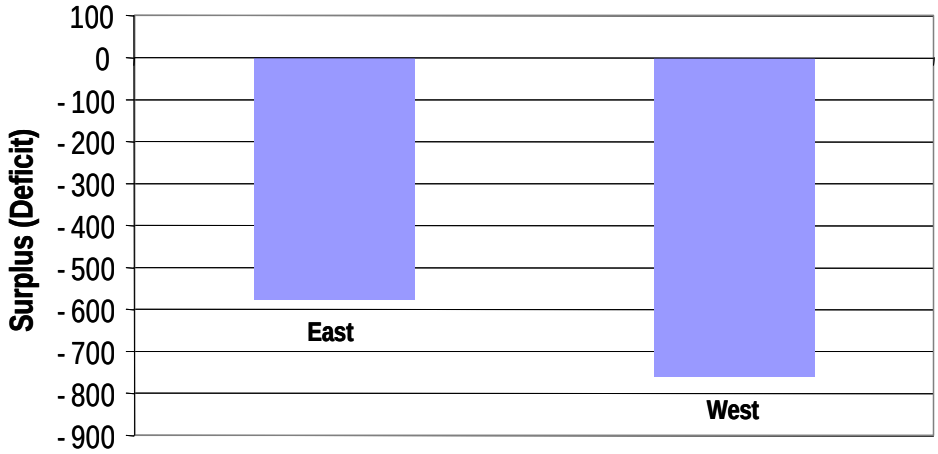


Figure 2-3: Projected Supply/Demand Balance in Bangladesh - 2007

2.2.2 Supply/Demand Situation in Bhutan

Bhutan is expecting a significant increase in domestic demand by the year 2010. The total demand is forecast to range from 200 MW to 225 MW. At the same time, the supply of hydropower is expected to greatly increase. However, the majority of future generation additions will be primarily for the export market. Approximately 6,300 MW of hydroelectric capacity has been planned or considered for future additions. However, over the period to 2007, it is probable that approximately 1,200 MW will be added. This will boost Bhutan's hydro-installed capacity to more than 1,500 MW by 2010. As a result, Bhutan is projected to have a surplus of capacity as shown in Figure 2-4.

Bhutan is expected to have a surplus of hydro-based capacity through 2010. Part of that surplus could be transmitted through the Four Borders interconnection to India and Bangladesh.

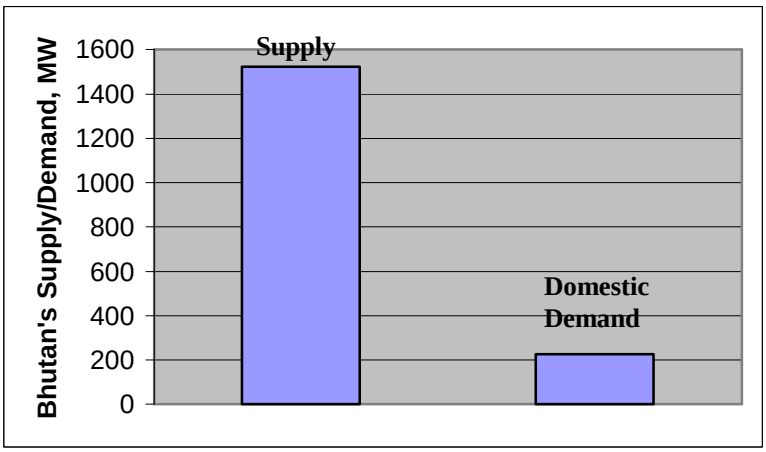


Figure 2-4: Projected Supply and Demand Situation in Bhutan - 2010

2.2.3 Supply/Demand Situation in Nepal

Nepal expects an annual average growth rate of 8.25% in demand (including export and domestic) for power. To meet this demand, Nepal Electricity Authority has put several projects under top priority after a preliminary screening and selection (see Table 2-3).

Table 2-3: Planned Hydroelectric Projects in Nepal

	Hydroelectric Project	Capacity MW	Expected Year of Commissioning
1	Khimti Khola II	27	2006
2	Kulekhani – III	42	2006
3	Likhu-4	40	2007
4	Upper Karnali	300	2008
5	Arun-3	402	2012
	Total	**811**	

The above HEP projects will raise Nepal's installed capacity to more than 1,400 MW by fiscal year 2011/2012 resulting in a wet season surplus of about 550 MW and a dry season surplus of about 475 MW as shown in Figure 2-5. Notwithstanding the displayed surpluses, Nepal will have need for small amounts of imported energy during certain months of the dry season.

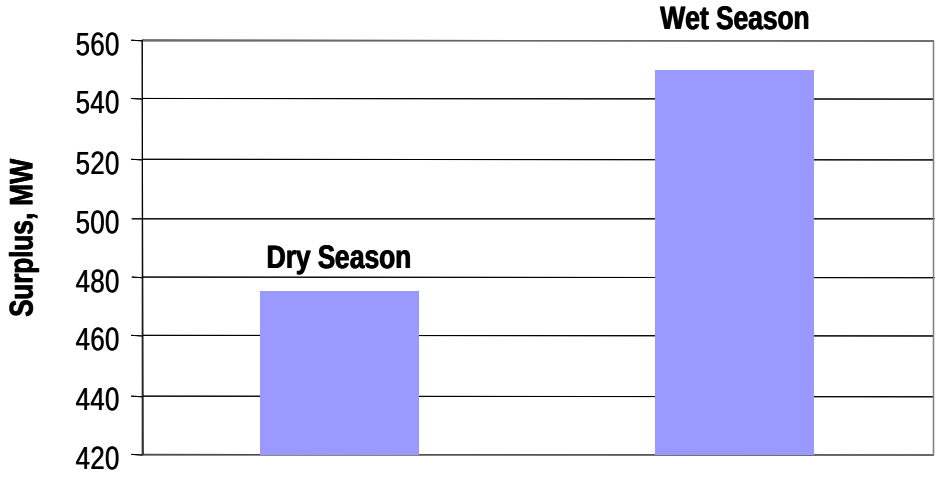


Figure 2-5: Projected Surplus Capacity in Nepal - 2011-2012

Nepal also is expected to have surplus hydro-based power that could be exported to India and Bangladesh through the Four Borders interconnection.

2.2.4 Supply/Demand Situation in India

A region's available capacity compared to peak load is one measure of its need for new capacity. Figure 2-6 illustrates the current supply/demand situation in the various regions of India using this comparison. The combined Eastern and Northeastern regions are estimated to have a 2,000 MW surplus while each of the Northern and Southern regions has a deficit of approximately 2,100 MW, and the Western region a deficit of about 4,500 MW. As discussed in the preceding section, the 220 kV interconnection with the Western region, the HVDC interconnection with the Southern region and the HVDC interconnection with the Northern region now under construction will allow some of the surplus of the Eastern and Northeastern regions to supply the deficit in the other regions. Even with this inter-connection, the Eastern and Northeastern regions will still have a surplus, while the Northern and Southern regions will have deficits. This situation is expected to persist through at least 2005.

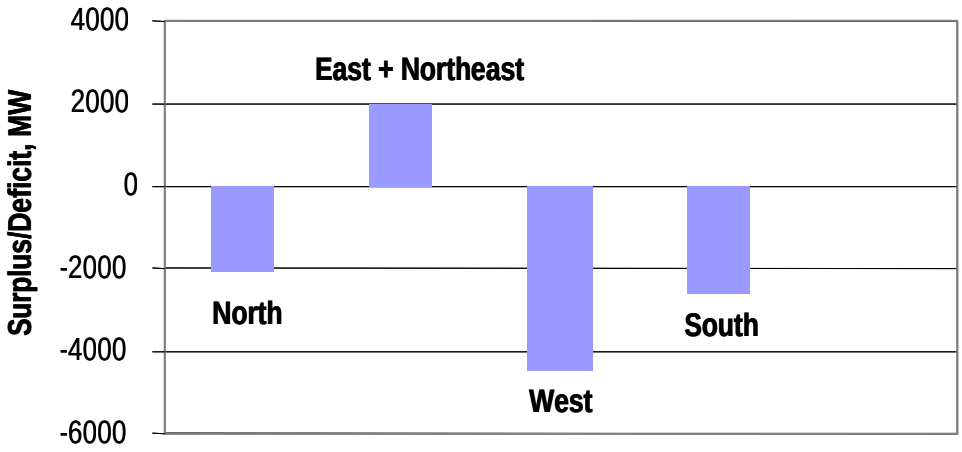


Figure 2-6: Regional Supply/Demand Balance for India for the Period 2001-2005

India's present and future supply and demand situation is shown in Table 2-4.

Table 2-4: India's Supply/Demand Scenario Through 2012

Region	Present Demand 2001 (MW)	Projected Demand 2012 (MW)	Planned Capacity Addition By 2012 (Central Govt.) (MW)	Surplus or Shortfall (MW)
Northern	21,000	49,000	14,000	(-) 14,000
Southern	20,400	42,000	10,000	(-) 12,000
Western	24,900	46,000	16,000	(-) 21,100
Eastern + Northeastern	8,750	19,000	23,000	(+) 12,750
Total	75,050	156,000	63,000	(-) 34,250

As indicated in the table, India faces a large generation shortfall by the year 2012 in spite of all the planned additions. Some of this shortfall is expected to be filled by the state utility companies and private investors. However, it is unlikely that all the planned additions will come on line as scheduled, and thus complete elimination of the shortfall would not be realized. The projected surplus power in the East and Northeast regions would not be adequate to meet the gap in demand. Consequently, India's generation expansion plans include importing power from neighboring countries.

India will have a significant power shortage through 2012. The Four Borders interconnection could help meet this need and contribute to transmission system stability and loss reduction.

As shown earlier, both Bhutan and Nepal expect to have surplus power by the end of the present decade. Bhutan expects about 1,300 MW and Nepal about 550 MW of surplus over that time period.

2.3 FOUR BORDERS COUNTRIES POTENTIAL FOR POWER TRANSFER

In summary, the supply and demand situation within the Four Borders countries clearly suggests that there is a strong potential for power transfer among these countries both in the near-term (next five years) as well as longer-term. In the short-term, opportunities for power transfer occur due to the need to exploit differences in seasonal demand patterns as well as for load balancing requirements. As shown above, the hydro-rich countries of Nepal and Bhutan have will have surplus capacity in the wet season. This coincides with seasonal peak demands in the supply-short countries – India and Bangladesh. In terms of load-balancing, hydro capacity provides better load following capability then the fossil-based systems in India and Bangladesh, and this would result in the more efficient use of resources.

Longer-term there is even more potential for transfer and trade due to the sheer growth in power requirements. As shown in Figure 2-7, while Bangladesh and India are critically short of power, Bhutan and Nepal are endowed with excess hydroelectric power. The current and planned generation expansion in the two power-surplus countries can partly meet the needs of the two power-deficit countries. However, if the generation potentials of both Nepal and Bhutan are exploited, they can be utilized to meet the needs of Bangladesh and India in the near-term as well as in the long-term. Given adequate commitment and resources, the generation capacity of both Nepal and Bhutan can be increased greatly to provide a long-term solution to the energy requirements of the Four Borders region.

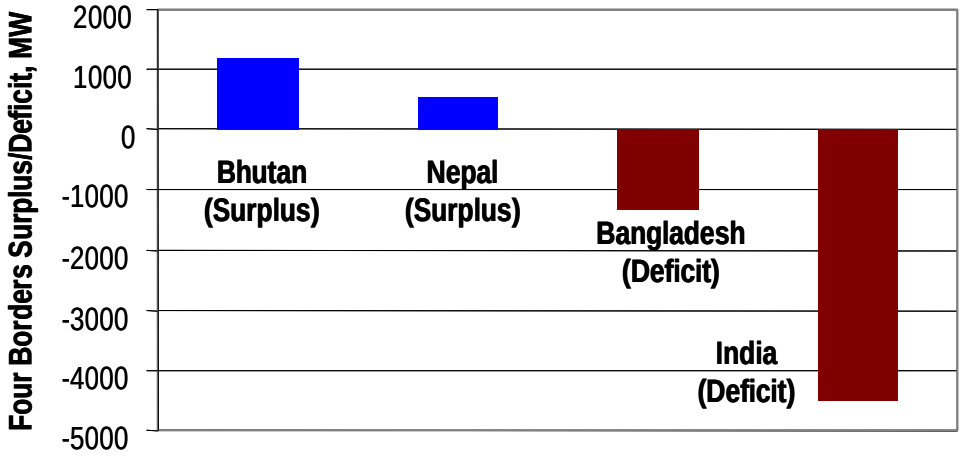


Figure 2-7: Power Transfer Potential in the Four Borders Region through 2010-2012

As shown in Figure 2-7, Bhutan should have a surplus of capacity of about 1,300 MW and Nepal about 550 MW in the 2010-2012 timeframe that could be exported to Bangladesh and India. At the same time, the unmet demand in these two countries is expected to be about 1,300 MW in Bangladesh and at least 4,500 MW in India. A regional system interconnection in the Four Borders Region could begin to address this regional supply/demand imbalance.

Section 3 Project Definition: Assessment of Options

This section outlines a range of options for the Four Borders Project and recommends a preferred option that would provide a basis for defining a specific project. As part of the preparation of this report, members of the Nexant team visited the Four Borders region to view the facilities and discuss options with regional stakeholders. On this basis, various options were considered.

This proposed interconnection has two objectives: First, it would enhance the reliability and system security of the individual countries through the diversity of sources of supply, ability to provide assistance in times of emergencies, and through the sharing of reserve requirements.

The Four Borders interconnection would contribute to system reliability and security of supply and facilitate development of regional energy transfer among Bangladesh, Bhutan, Nepal and India.

Second, the interconnection would facilitate the development of regional energy transfer among the four countries. Currently, Bhutan and, to a limited extent, Nepal trade power through bilateral arrangements with India. The proposed interconnection would expand the combination of parties that could enter into new bilateral trading arrangements in the short-term as well as make possible over the longer-term the advent of multilateral energy trading arrangements.

Other options to achieve increased power transfer in the region are available. For example, it has been pointed out that transmission connections to Nepal, Bhutan or Bangladesh could connect with the nearest substation in India without being centralized at a Four Borders substation. However, these interconnections would only provide for additional bilateral power arrangements with India. The purpose of this pre-feasibility study is to investigate options that would promote multilateral power arrangements and cooperation that would involve all four countries. This type of approach is believed to provide benefits beyond those available through additional limited bilateral arrangements.

3.1 DEFINITION OF OPTIONS

3.1.1 Rationale

In developing options for a Four Borders interconnection, consideration was given to the following factors:

- Existing and planned generating capacity in each country;
- Existing and planned transmission systems in each country;
- Time frame for development; and
- Technical and operational factors.

The rationale of this approach is that the options under consideration would be consistent with the development plans in each country.

For example, with the development of the Tala hydroelectric generating facility in Bhutan, a new 400 kV transmission interconnection between Bhutan and India is under development that would go through the Four Borders Region. This transmission system expansion has been selected to be used in conjunction with the proposed Four Borders Project. In addition, new 220/400 kV substations are under construction at Siliguri and Purnea to serve as the substations for the evacuation of up to 1,000 MW from the Tala HEP. The sites of these new substations have been investigated to assess their suitability to be expanded to include the facilities needed for the proposed Four Borders Project.

Accordingly, all of the suggested options presented in this report utilize the Tala-Siliguri-Purnea 400 kV transmission line as the interconnection between India and Bhutan. Nepal and Bangladesh are interconnected with India and Bhutan at either of the two substations, Siliguri or Purnea. Also, upon completion of each option, the Four Borders grid would be operated as an integrated and synchronized system between India, Nepal, Bhutan and Bangladesh.

All options reviewed for the Four Borders Project use existing transmission facilities as much as possible. This reduces costs and minimizes environmental impacts.

Between these two substations is a narrow land strip in the Siliguri district of West Bengal bordered by Nepal to the west, Bangladesh to the east, and Bhutan to the north. The total area of this land strip is 18 kilometers in length by 22 kilometers in width. This area has been traditionally referred to as the "chicken-neck" region of northeastern India. Obviously, land available for transmission line right-of-way through this land strip is limited. Future transmission expansion plans of Power Grid Corporation India for this area would utilize all remaining rights-of-way.

To avoid this congestion and minimize the environmental impact of the proposed Four Borders project, none of the options analyzed in this report involve constructing additional transmission lines through this land strip. Rather, the new transmission interconnection would circumvent this potential bottleneck. Three possible options that bracket the range of relevant possibilities are presented below.

The timeframe for development of these interconnections should be in line with the growing need for energy in western Bangladesh and the development of hydroelectric power generating facilities in Nepal and Bhutan. Taking into consideration the time necessary for design, permitting, and construction of transmission facilities, it is reasonable to expect that a transmission expansion project would be able to be in place within a five-year period. This is consistent with the supply/demand review presented in the previous section that suggests that there could be a tradable surplus of power in Bhutan and Nepal by 2005.

None of the options proposed involve new transmission lines through the congested "chicken neck" region of India.

Finally, in developing these options, a range of technical possibilities was considered based on considerations for transmission system stability.

During the course of this study it was suggested by some regional stakeholders that the transmission lines connecting the Four Borders Project with regional transmission systems be constructed at the 400 kV level, rather than at the 132 kV or 220 kV level as suggested below. This suggestion was made due to the difficulty in obtaining rights-of-way and other environmental approvals in this region. The fear was that if lines were constructed at the 132 kV or 220 kV voltage level and regional demand grew so that a larger transfer capacity was needed, it would be very difficult and time consuming to obtain permission to upgrade line capacity to 400 kV.

This viewpoint has merit. However, given the relatively limited amount of power currently available for transfer and the likelihood that additional generating capacity will not be available for some time (based on review of the expansion plans of the four countries), it was felt that the options reviewed in this pre-feasibility study provide a reasonable match between current and expected future costs and benefits.

Given the above parameters, three basic options are developed and reviewed in this report. These include:

- **Option A:** Limited Power Transfer (132 kV);
- **Option B:** Moderate Power Transfer - Accelerated Development (220 kV); and
- **Option C:** Moderate Power Transfer - Phased Development.

For each of these options, the following variants were considered:

1. Interconnection point at the Siliguri 400/220 kV substation;
2. Interconnection point at the Purnea 400/220 kV substation;
3. Use of DC back-to-back interconnection; and
4. Locating the control center at a facility other than the Siliguri or Purnea substations.

Figure 3-1 shows the geographic configuration of the interconnections. Each option is discussed in detail in the following sections.

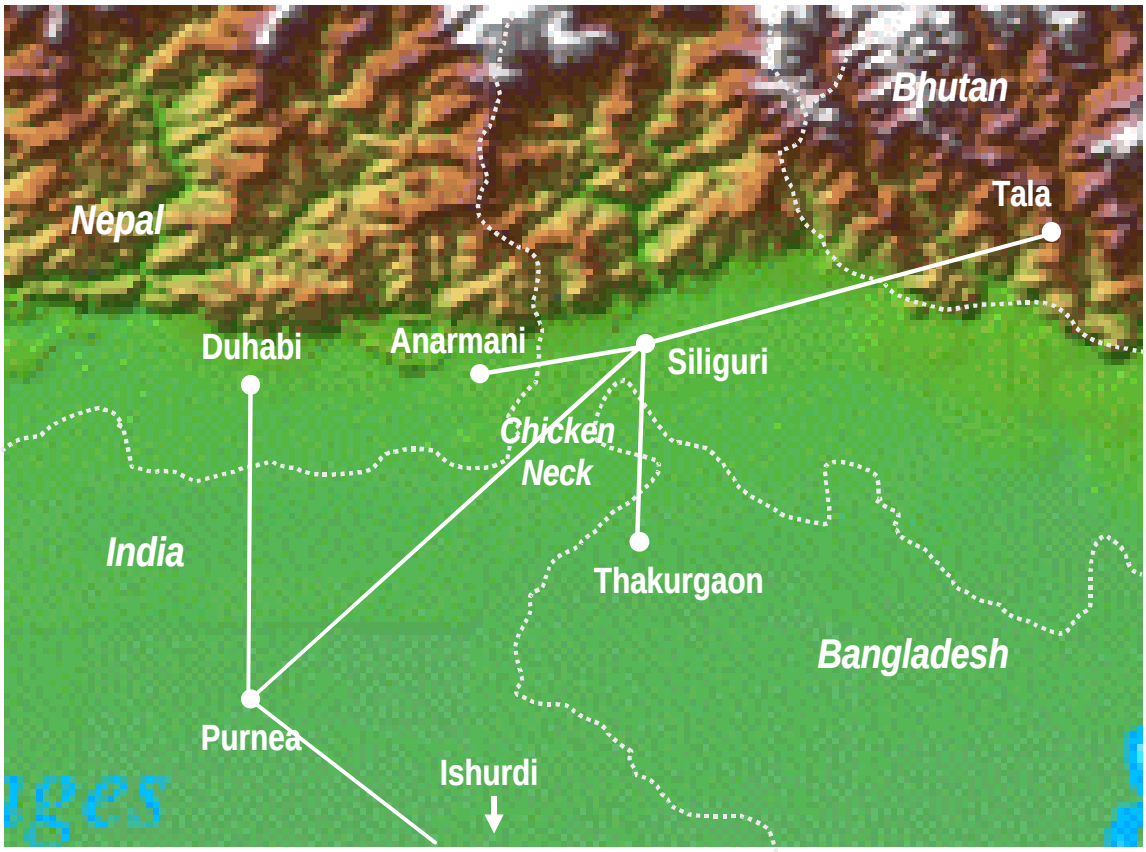


Figure 3-1: Geographic Configuration of the Interconnections

3.1.2 Option A: Limited Power Transfer (132 kV Expansion)

Option A proposes the simplest interconnection between Bangladesh, Bhutan, India, and Nepal. By using the Tala related transmission interconnection between India and Bhutan, which is currently under development, and the existing 132 kV facilities in Nepal and Bangladesh as the terminus points for the new transmission line interconnection. This transmission interconnection would satisfy the objective of increasing system reliability and security, and it also would provide a limited capacity for economic energy trades between the countries.

Option A includes two variations, which are outlined below. The first, Option A1, would construct the new Four Borders interconnection at the new Siliguri 400/220 kV substation, which is currently under construction to evacuate power from the Tala HEP. The second variation, Option A2, would construct the Four Borders interconnection at the new Purnea 400/220 kV substation, which is under construction to evacuate power from the Tala HEP and from the Northeastern Region of India. The details of each of these two options are outlined below and are represented in the associated schematic diagrams.

3.1.2.1 Option A1: Interconnection at the Siliguri 220 kV Substation

Figure 3-2 shows the line diagram for Option A1, which would locate the Four Borders interconnection at the new Siliguri substation. Implementation of this option would require the following:

- Construct a new 132 kV substation (Four Borders) adjacent to the new Siliguri 400/220 kV substation;
- Install a 220/132 kV transformer at the Four Borders substation and connect a feeder line from this transformer to the new Siliguri 220 kV substation; and
- Construct a new 132 kV transmission line from the Four Borders substation to the Anarmani 132 kV substation in Nepal (50 km) and to the Thakurgaon 132 kV substation in Bangladesh (90 km).

The transmission system configuration for this option is presented in the following map and the line diagram is provided in Figure 3.2.

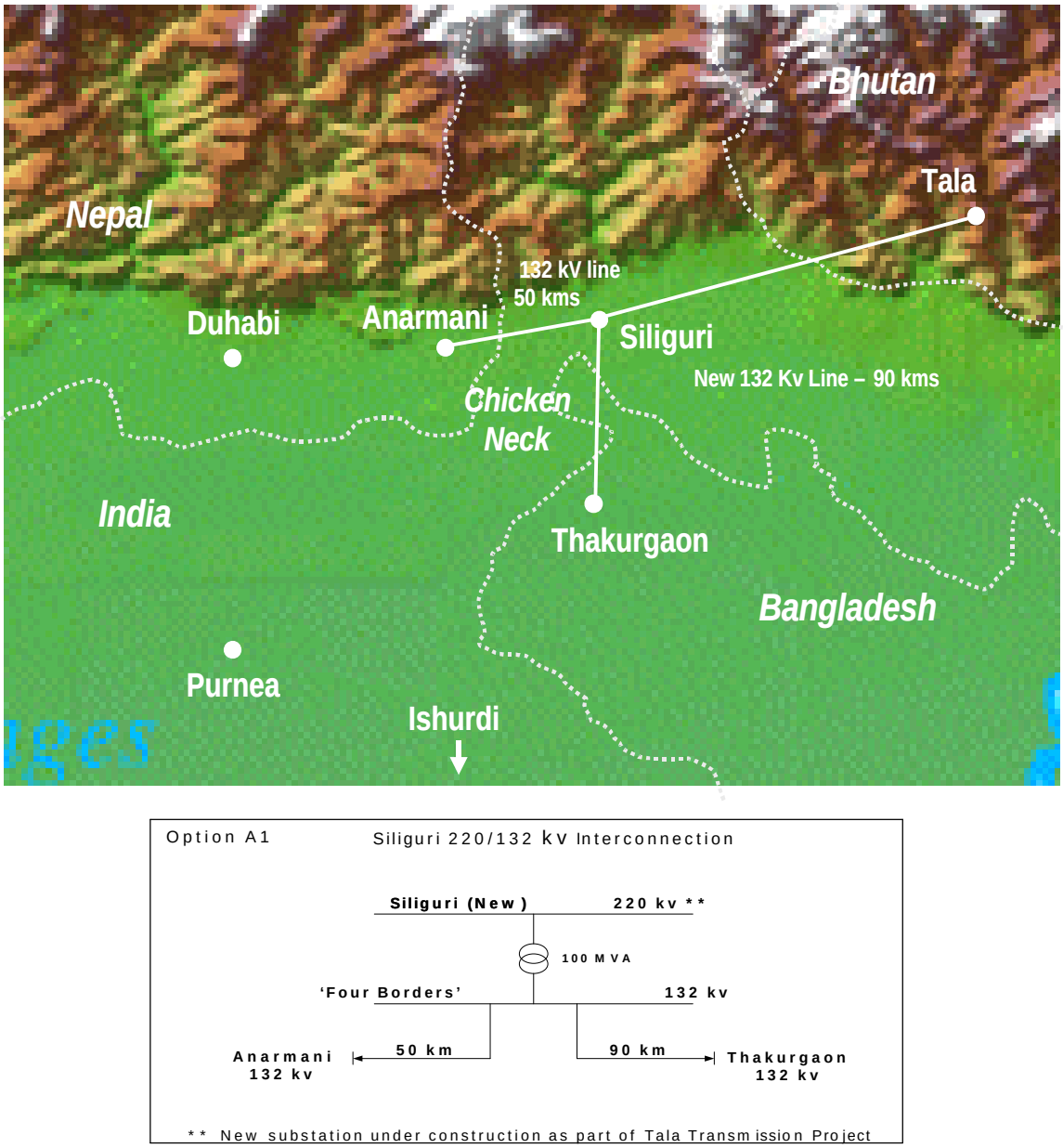


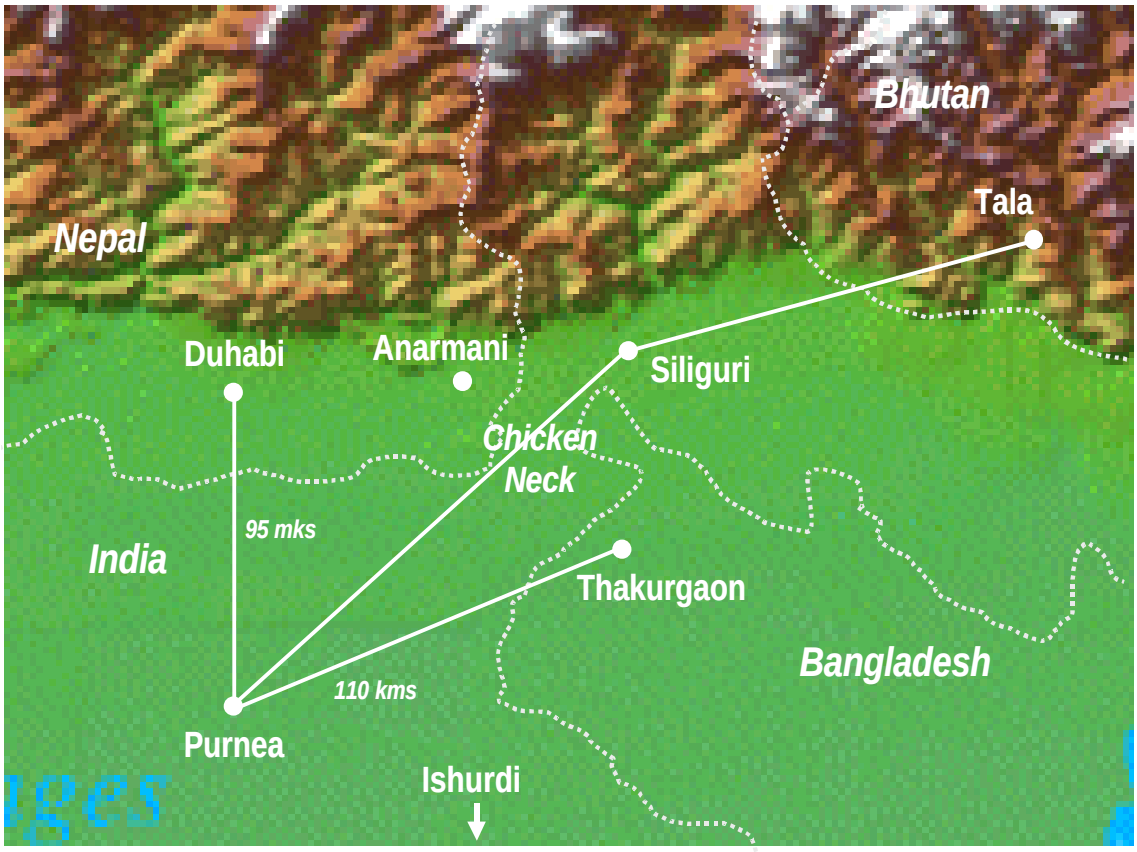
Figure 3-2: Option A1: Interconnection at the Siliguri 220 kV Substation

3.1.2.2 Option A2: Interconnection at the Purnea 220 kV Substation

Figure 3-3 shows the line diagram for Option A2. Option A2 would locate the Four Borders interconnection at the new Purnea 400/220 kV substation, rather than at the Siliguri substation as in Option A1. Implementation of the option would require the following:

- Construct a new 132 kV substation (Four Borders) adjacent to the new Purnea 400/220 kV substation;
- Install a 220/132 kV transformer at the Four Borders substation and connect a feeder line from this transformer to the new Purnea 220 kV substation; and
- Construct a new 132 kV transmission line from the Four Borders substation to the Duhabi 132 kV substation in Nepal (95 km) and to the Thakurgaon 132 kV substation in Bangladesh (110 km).

The transmission system configuration for this option is presented in the following map.



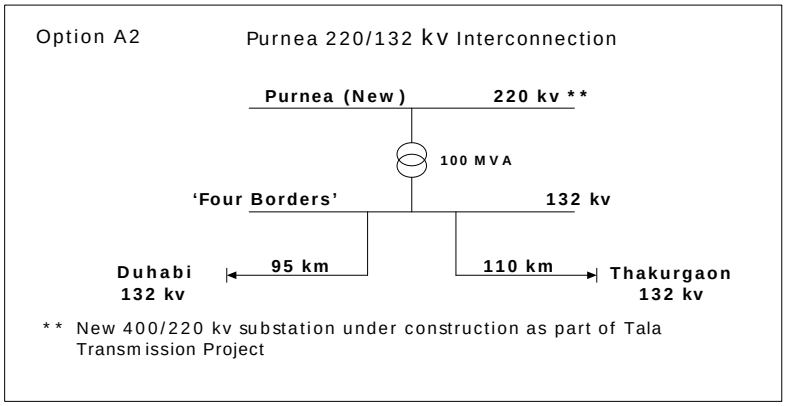


Figure 3-3: Option A2: Interconnection at the Purnea 220 kV Substation

3.1.3 Option B: Moderate Power Transfer – Accelerated Development (220 kV Expansion)

While Option A satisfies the objective of increased system reliability and security, it does little to address the current and anticipated future supply deficiency in western Bangladesh, as the transfer capacity of the proposed interconnection for both Option A1 and Option A2 is limited to about 150 MW.

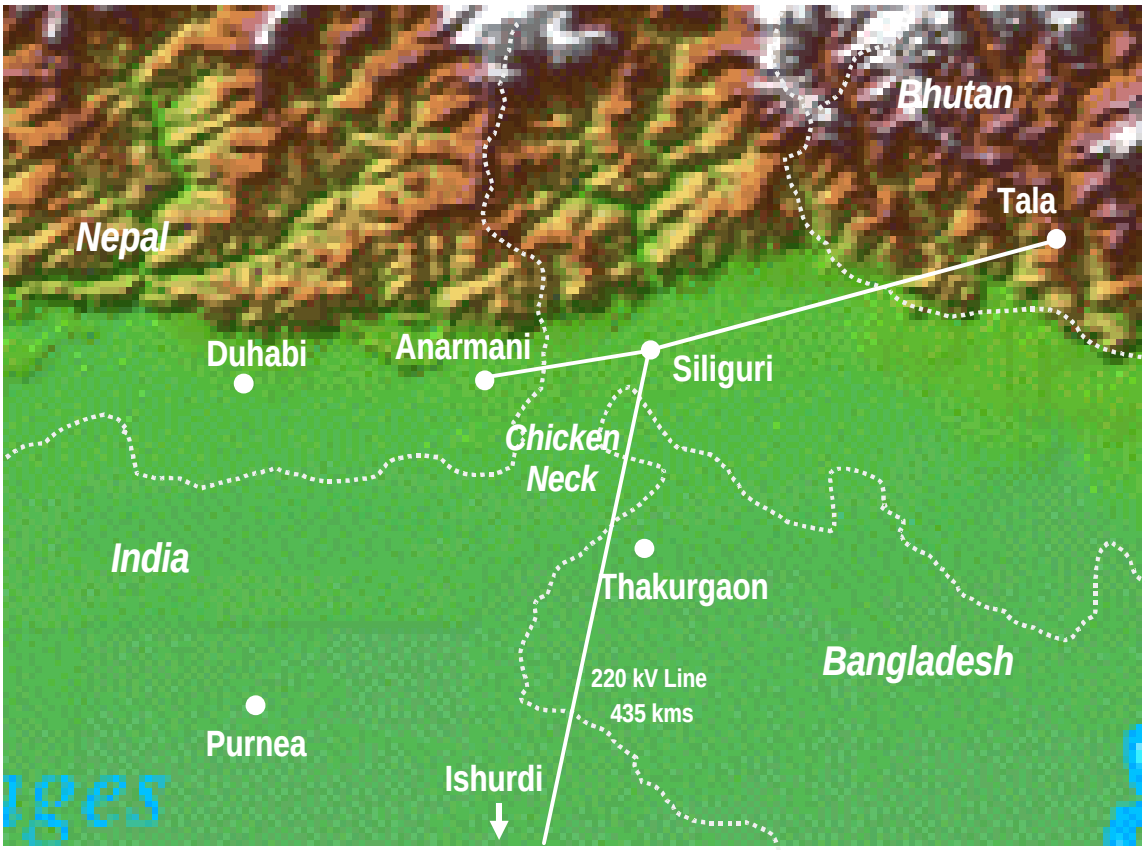
To address this need for greater transfer capability, Option B would increase the voltage of the proposed Four Borders interconnection from 132 kV to 220 kV. This increase in voltage would increase the transfer capability of the interconnection from approximately 150 MW to up to 500 MW.

Option B also has two variations. Option B1 would construct the Four Borders interconnection at the new Siliguri 400/220 kV substation and would also connect to the existing 220kV substation at Ishurdi in Bangladesh, rather than at the 132 kV substation at Thakurgaon, Bangladesh as in Option A1. The terminus point in Nepal for Option B1 remains at the existing 132 kV facility at Anarmani. Nepal lacks a 220 kV transmission system at this time and has no near term plans to construct 220 kV transmission facilities in the area of Anarmani.

3.1.3.1 Option B1: Interconnection at the Siliguri 220 kV Substation

The map below shows the transmission system interconnection for Option B1. The line diagram for this option is displayed in Figure 3.4. Implementation of this option would require the following:

- Construct a new 220/132 kV Four Borders substation adjacent to the new Siliguri 400/220 kV substation, and connect it via a feeder line from the new Siliguri 220 kV substation;
- Install a 220/132 kV transformer at the Four Borders substation;
- Construct a new 132 kV transmission line from the Four Borders substation to the Anarmani 132 kV substation in Nepal (50 km); and
- Construct a new 220 kV transmission line from the Four Borders substation to the Ishurdi 220 kV substation in Bangladesh (435 km).



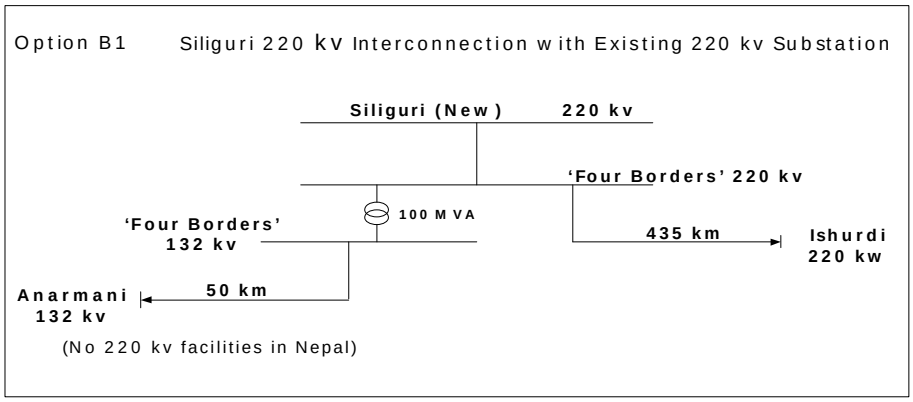


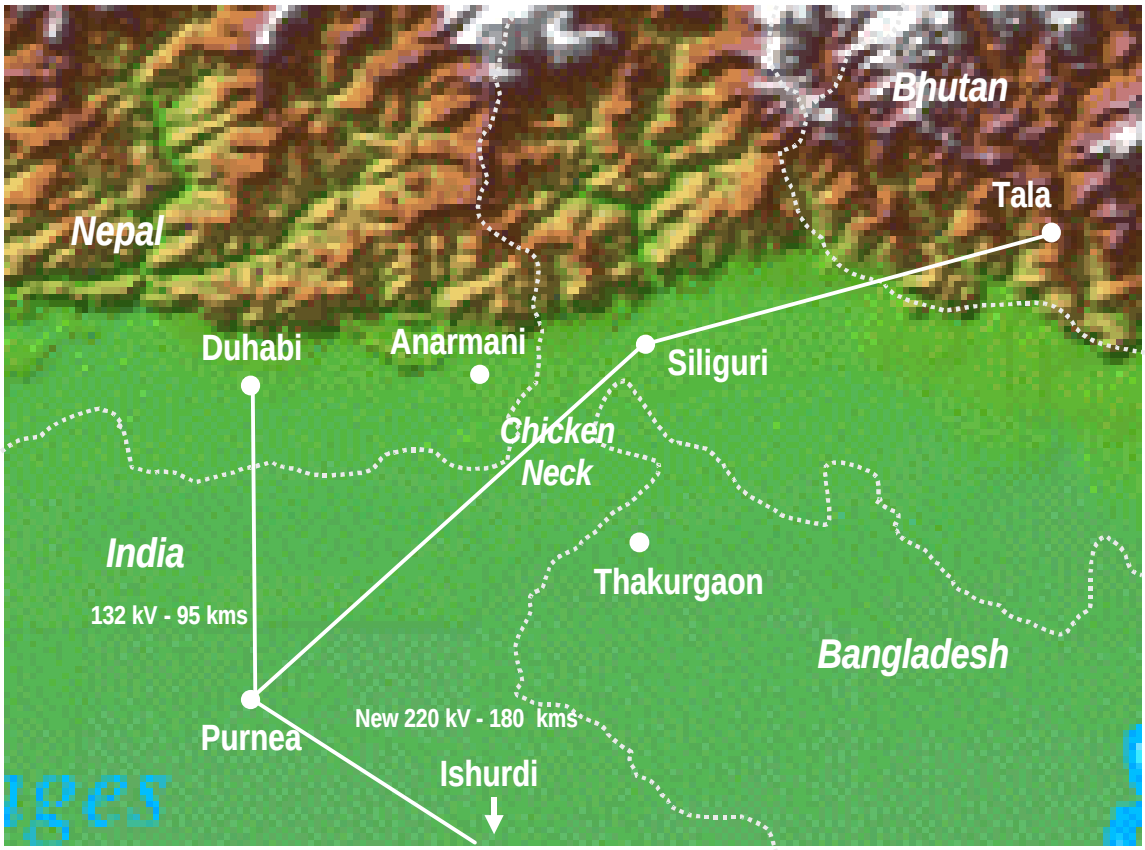
Figure 3-4: Option B1: Interconnection at the Siliguri 220 kV Substation

3.1.3.2 Option B2: Interconnection at the Purnea 220 kV Substation

Option B2 would construct the proposed Four Borders interconnection at the new Purnea 220kV substation, rather than at the Siliguri substation as in Option B1. The transmission system configuration for this option is shown in the map below. Figure 3-5 shows the line diagram for this proposed option.

Implementation of Option B2 would require the following:

- Construct a new Four Borders 220/132 kV grid substation adjacent to the new Purnea 400/220 kV substation, and connect it via a feeder line from the new Purnea 220 kV substation;
- Install a 220/132 kV transformer at the Four Borders substation;
- Construct a new 132 kV transmission line from the Four Borders substation to the Duhabi 132 kV substation in Nepal (95 km); and
- Connect the existing Purnea-Farakka 220 kV transmission line to the Four Borders 220 kV substation, and extend the Purnea-Farakka transmission line to the Ishurdi 220 kV substation in Bangladesh (180 km).



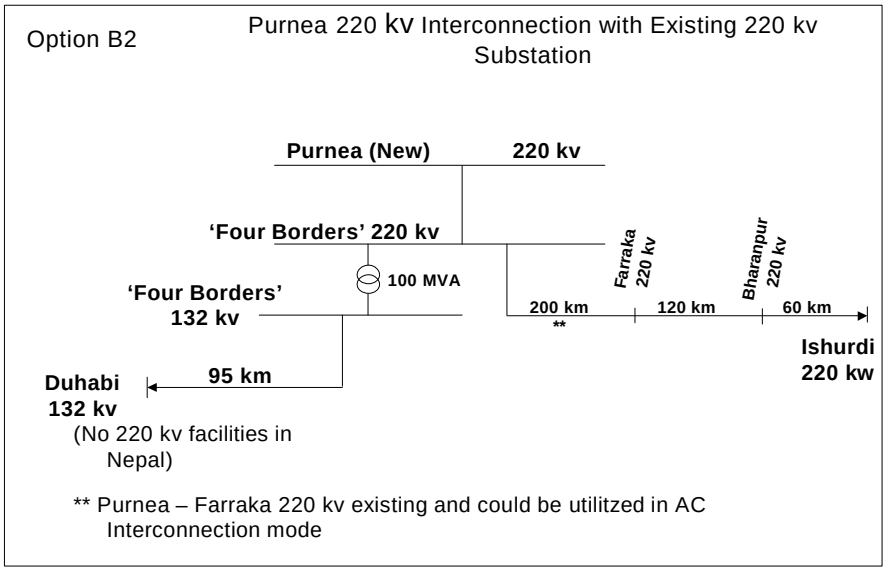


Figure 3-5: Option B2: Interconnection at the Purnea 220 kV Substation

3.1.4 Option C: Moderate Power Transfer – Phased Development

A third option, Option C, for the proposed Four Borders interconnection also has been investigated. Option C presents a phased approach to the development of transmission line inter-connections between the countries in an attempt to capture both the simplicity of Option A and the greater transfer capability of Option B.

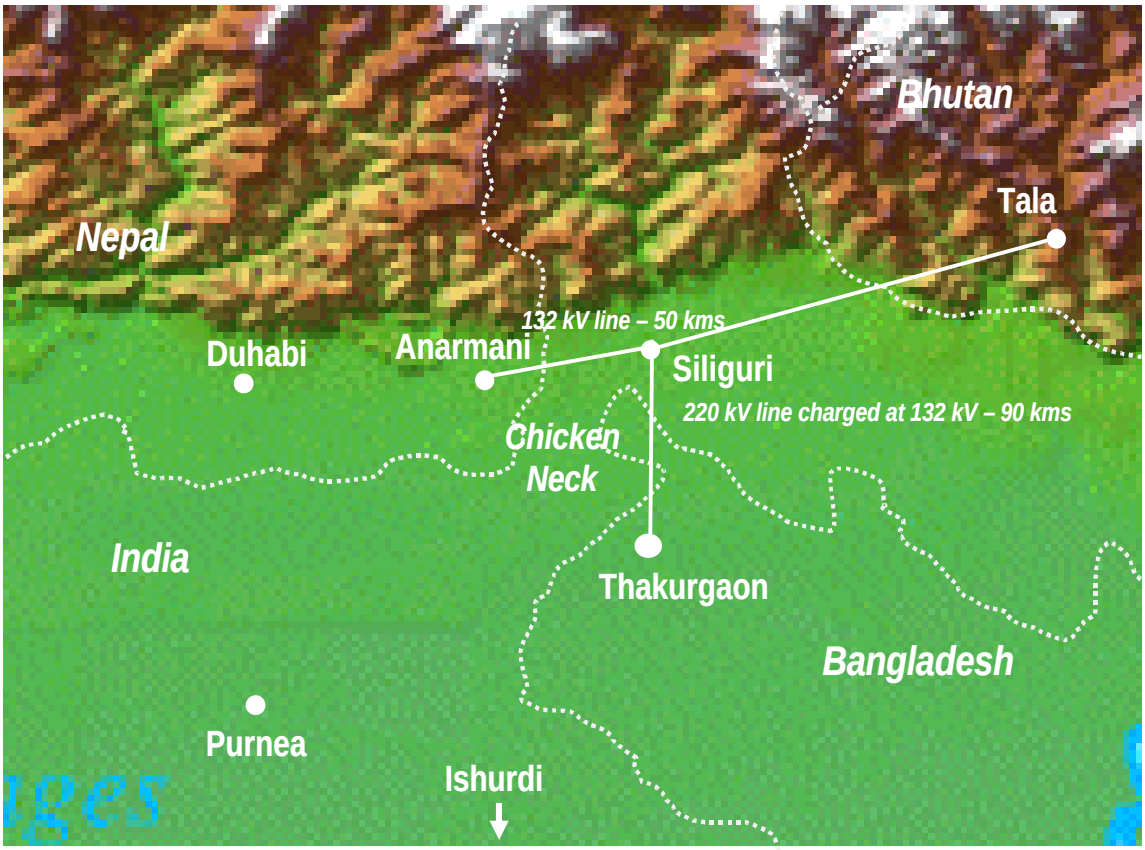
Options A1 and A2 would only allow about 150 MW of power to be traded through the Four Borders interconnection. This would contribute to the current power needs of Bangladesh and India, but would not allow for further expansion to meet expected future power needs. Options B1 and B2 would increase this transfer capability to about 500 MW by increasing the size of the transmission lines from 132 kV to 220 kV. However, because Bangladesh and Nepal currently have no 220 kV transmission lines in the Four Borders Region (although Bangladesh has plans to build such lines), connection at 220 kV would require a much longer and more costly interconnection to reach the existing 220 kV transmission system in Bangladesh. Thus, while these options would allow the interconnected countries to meet the expected higher future power needs, they would incur costs now to construct facilities that would not be used until sometime in the future.

Option C, through its two variations, Option C1 and Option C2, attempts to address this trade-off between current and future power needs by using a phased approach to constructing the Four Borders interconnection. Phase I of both of these options would build a 220 kV transmission line but only energize and operate the line at 132 kV. Phase II of these options would upgrade the interconnection to 220 kV after the regional power market and related transmission facilities justified this expansion. This would delay the expenditure for these larger facilities until such time as they were needed, resulting in a better match of costs and benefits.

As with Options A and B, Option C has two variations. Option C1 would construct the Four Borders interconnection at the Siliguri 400/220 kV substation, and Option C2 would build it at the Purnea 400/220 kV substation.

3.1.4.1 Option C1: Interconnection at the Siliguri 220kV Substation

The transmission system interconnection for Phase I of this option is shown in the following map. Implementation of this phase of Option C1 would require the following:

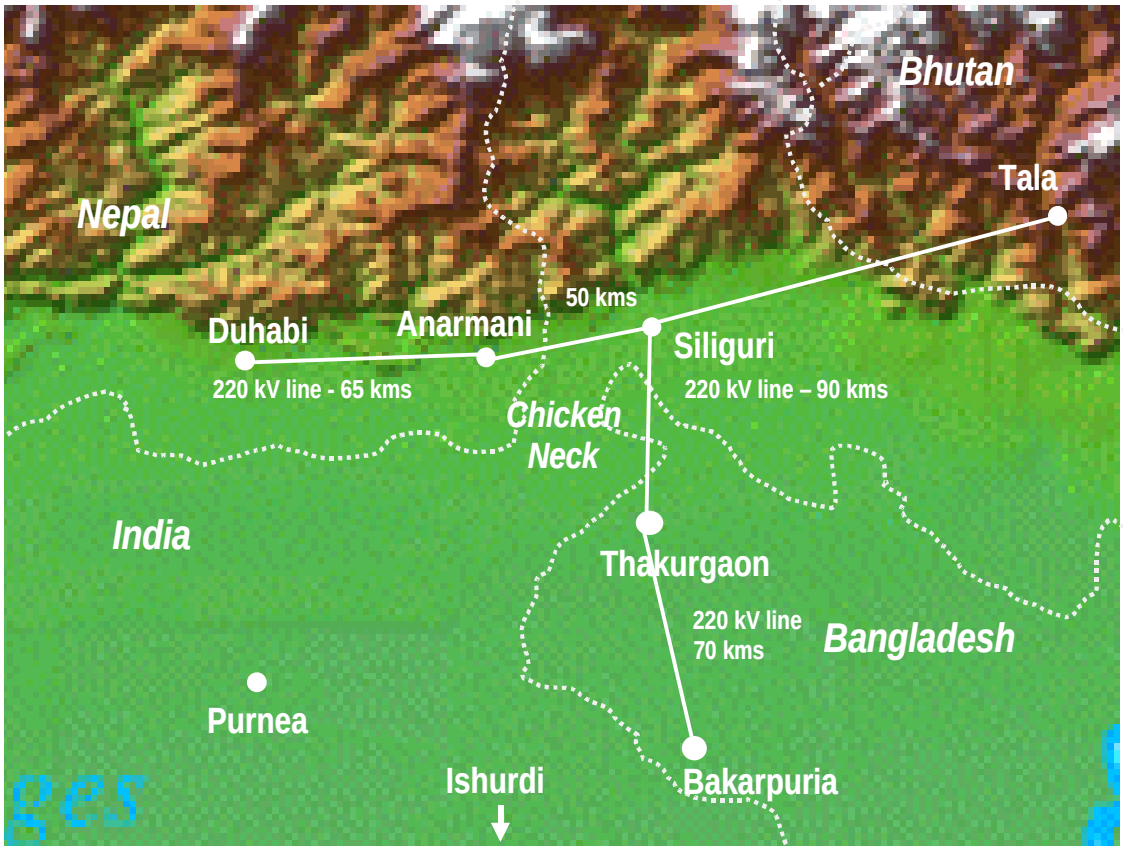


Option C1: Phase I

- Construct a new Four Borders 220 kV grid substation adjacent to the new Siliguri 400/220 kV substation;
- Install a 220/132 kV transformer at the Four Borders substation, and connect this transformer to the new Siliguri 220 kV substation via a feeder line; and
- Construct a new 220 kV transmission line to initially be operated at 132 kV from the Four Borders substation to the Anarmani 132 kV substation in Nepal (50 km) and to the Thakurgaon 132 kV substation in Bangladesh (90 km).

Option C1: Phase II

The transmission system configuration for Phase II of this option in shown in the following map. Implementation of this phase of Option C1 would require the following:



- Install a 220 kV feeder from the new Siliguri 220 kV substation to the Four Borders 220 kV substation;
- Disconnect the previous Four Borders to Thakurgaon 132 kV transmission line from the Thakurgaon 132 kV substation, and construct a 220 kV transmission line extension from Thakurgaon to the Bakarpuria 220 kV substation (additional 70 km);
- Disconnect the previous Four Borders to Anarmani 132 kV transmission line from the Anarmani 132 kV substation, and construct a 220 kV transmission line extension from Anarmani to the Duhabi 220 kV substation (additional 65 km); and
- Retire the 220/132 kV transformer at the Four Borders substation.

Figure 3-6 presents the line diagram for both Phase I and Phase II of this option.

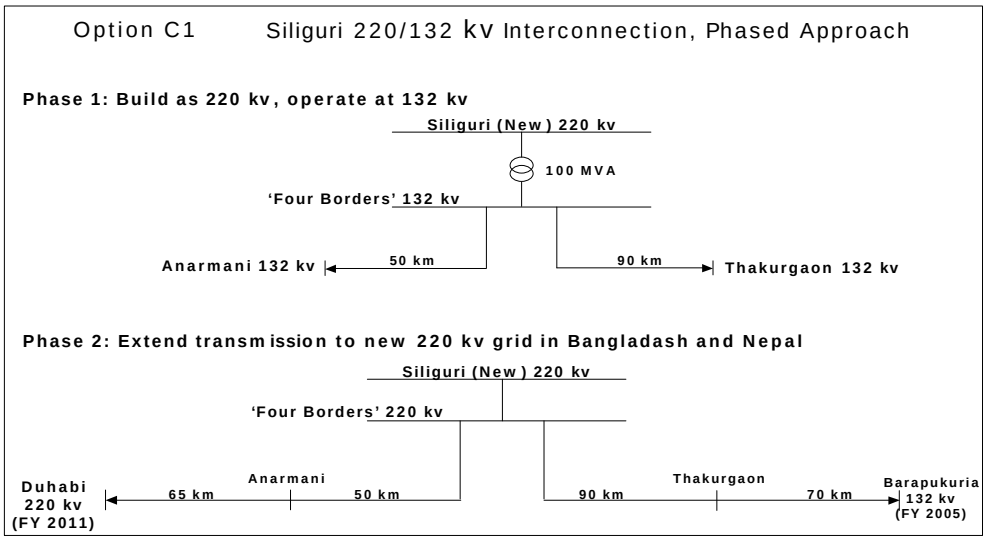


Figure 3-6: Option C1, Phase I and Phase II: Interconnection at the Siliguri 220 kV Substation

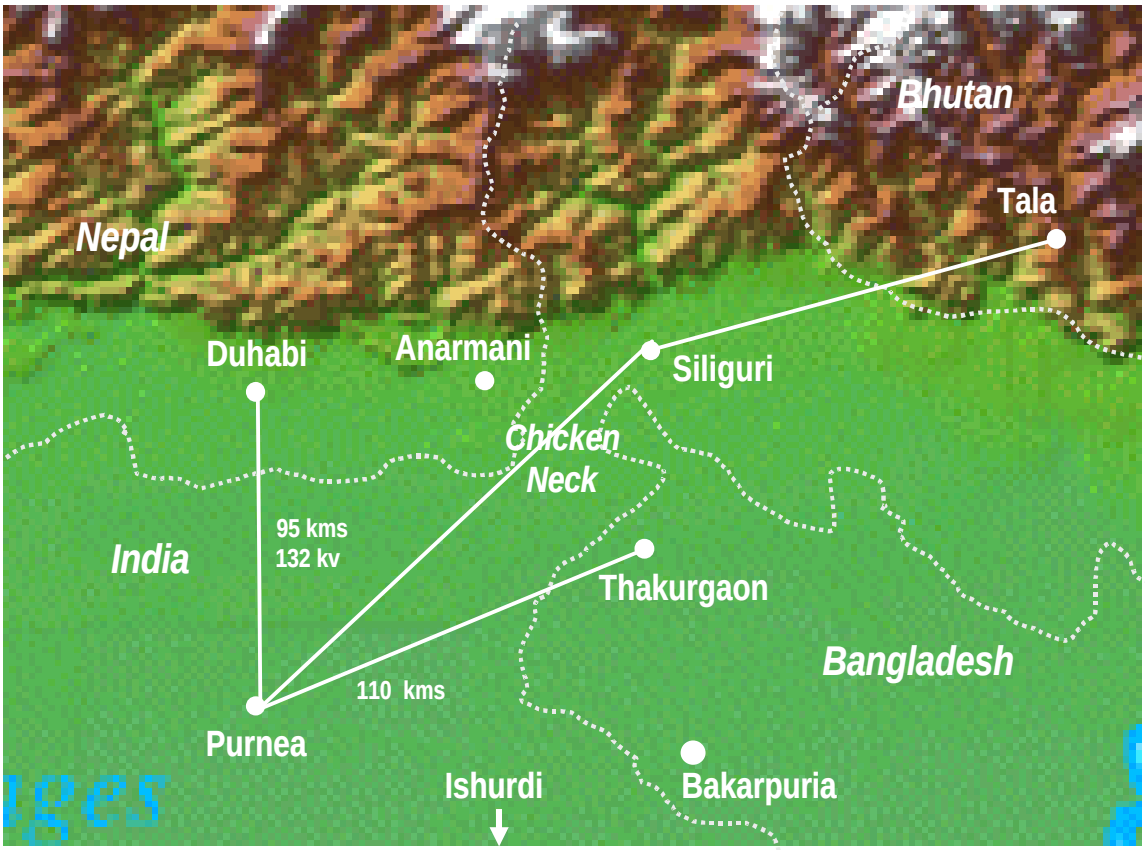
An alternative interconnection configuration for Option C1 is to connect Siliguri with Barapukura via Syedpur instead of via Thakurgaon. This alternative would better match with Bangladesh's most recent transmission expansion plan (based on comments provided by the Bangladesh power sector). Refinements to the options presented in this report, based on the most recent information and data available, should be developed within a full feasibility study with participation by power sector participants from each of the Four Border countries.

3.1.4.2 Option C2: Interconnection at the Purnea Substation

The transmission system interconnection for Phase I of this option is shown in the following map. Implementation of Phase I of this option would require the following:

Option C2: Phase I

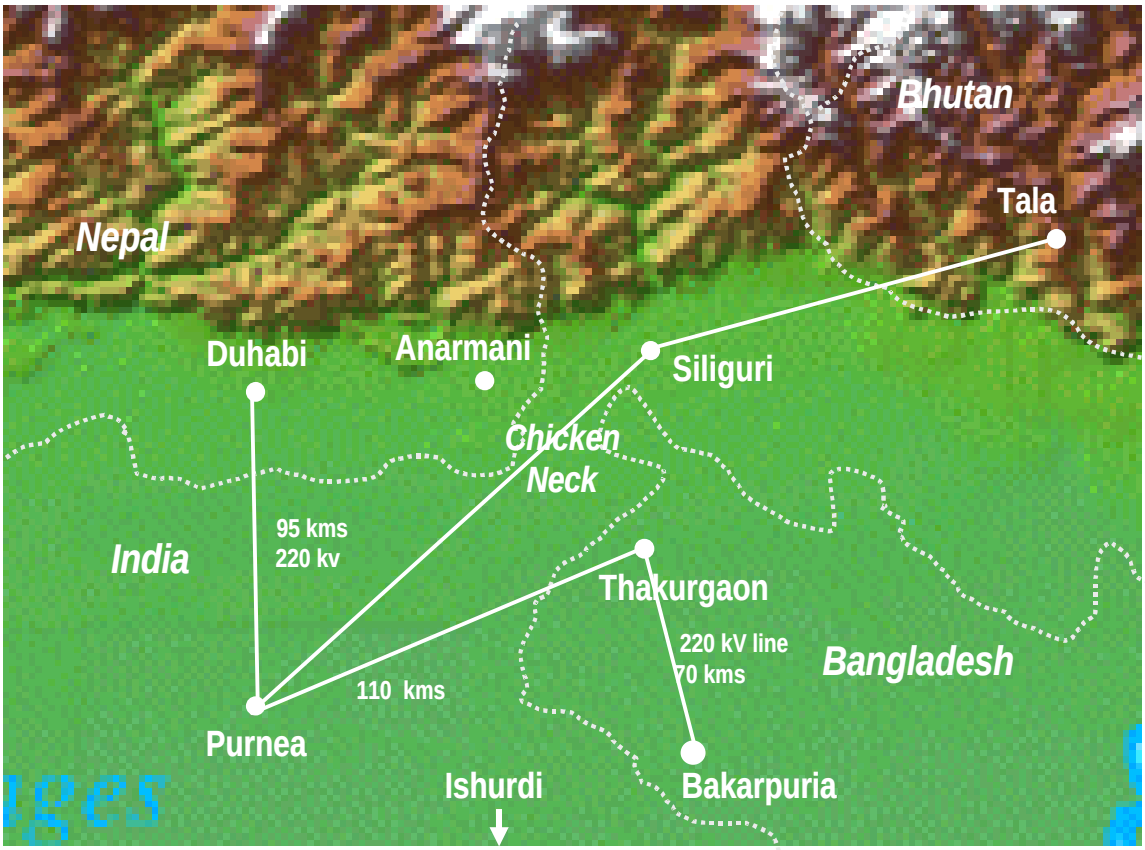
- Construct a new Four Borders 220 kV substation adjacent to the new Purnea 400/220 kV substation;
- Install a 220/132 kV transformer at the Four Borders substation, and connect this transformer to the new Purnea 220 kV substation via a feeder line; and
- Construct a new 220 kV transmission line to initially be operated at 132 kV from the Four Borders substation to the Duhabi 132 kV substation in Nepal (95 km) and to the Thakurgaon 132 kV substation in Bangladesh (110 km).



Option C2: Phase II

The transmission system configuration for Phase II of this option is shown in the following map. Implementation of Phase II of this option would require the following:

- Install a 220 kV feeder from the new Purnea 220 kV substation to the Four Borders 220 kV substation;
- Disconnect previous Four Borders to Thakurgaon 132 kV transmission line from the Thakurgaon 132 kV substation, and construct a 220 kV transmission line extension from Thakurgaon to the Bakarpuria 220 kV substation (additional 70 km);
- Connect the previous Four Borders to Duhabi 132 kV transmission line into the new Duhabi 220 kV substation, which is scheduled for completion in fiscal year 2010; and
- Retire the 220/132 kV transformer at the Four Borders substation.



Phase I and Phase II of this option are represented in the line diagram shown below in Figure 3-7.

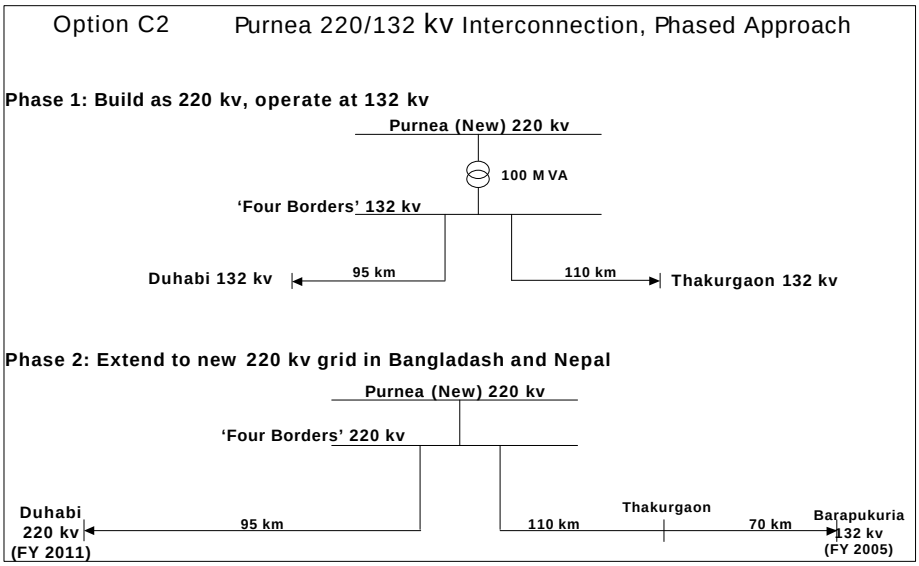


Figure 3-7: Option C2, Phase I and Phase II: Interconnection at the Purnea 220 kV Substation

3.1.5 Variations on Options

In addition to the three options represented above, two additional variations for the proposed Four Borders Project were considered and assessed. The first variation considered installing direct current (DC) back-to-back ties between the Four Borders substation and the India point of interconnection at either the Siliguri or Purnea substations. This variation was considered to address the concerns about transmission system instability that currently is a problem on India's transmission system. There is concern that if the Bangladesh and Nepal systems are interconnected to India via an alternating current (AC) interconnection, these systems would be subject to India's instability problems. India's over-frequency plight can be isolated through the use of a DC back-to-back interconnection instead of the AC interconnection, although at a significantly higher cost. This variation would have no or little impact on siting or length of transmission additions required. However, it would impact the overall cost of the interconnection project.

The second variation for the Four Borders Project was to locate the control facility for the transmission interconnection in Bhutan, Nepal or Bangladesh rather than at the planned control facilities at the Siliguri or Purnea substations in India. The reason for this variation is to address the concerns of these countries that India might have too much control over the proposed interconnection.

Each of these variations will be address in section 3.2.4 below.

3.2 TECHNICAL ASSESSMENT

3.2.1 Assessment of Option A: Limited Power Transfer

Option A is the most straightforward of the options for construction the Four Borders interconnection. The amount of energy that can be transferred through this option is up to 150 MW. This amount of energy is within the current capability of the countries to absorb or supply electrical power. Nepal is currently importing on average 50 MW from India, and it is estimated that the western region of Bangladesh would benefit from the import of up to 150 MW of energy in the short-term.

Options A1 and A2 are easy to implement, but would limit the amount of power that could be transmitted through the Four Borders interconnection to 150 MW.

The disadvantage of Option A is that it does not adequately factor in the developmental plans and projections of the countries in the region. The demand projections for western Bangladesh demonstrate a serious deficit of energy by fiscal year 2007 of up to 750 MW. Likewise, Nepal will be in the position, after the development of hydroelectric generating facilities, to export energy in excess of 150 MW to India and Bangladesh. A 132 kV transmission interconnection would not be able to support energy transfers of this magnitude. Further, preliminary load flow analysis of the 132 kV interconnection scenario indicated that there could be degradation of voltage if the interconnection was operated as an synchronous AC interconnection. While a DC back-to-back tie might mitigate the voltage problem, such an addition would significantly add to the overall costs of the 132 kV interconnection option.

With regard to the difference between Option A1 and Option A2, both Siliguri and Purnea substations have vacant facilities that could be used to connect to the proposed Four Borders substation. Both substations have adjacent land available that would be suitable for the siting of the Four Borders substation and interconnection. The transmission line lengths required for interconnection are less from the Siliguri substation (140 km) than from the Purnea substation (205 km), thus reducing the cost of Option A1 as compared to Option A2. Otherwise there is no obvious technical advantage to prefer Option A1 over Option A2 or vice versa.

3.2.2 Assessment of Option B: Moderate Power Transfer – Accelerated Development

Option B attempts to address the limited energy transfer capability of Option A by interconnecting the four countries at 220 kV rather than at 132 kV.

India and Bhutan are already interconnected at 220 kV through the evacuation of energy from the Chukka hydroelectric facility. The interconnection between India and Bhutan will be strengthen by the addition of the 400 kV Tala interconnection that is currently being developed. India has an extensive 220 kV grid in the Eastern Region.

In contrast, Bangladesh has limited 220 kV transmission sites centered around Dhaka and a single east-west transmission interconnection terminating at the Ishurdi substation. There are plans, as yet unfunded, to extend the 220 kV grid north from Ishurdi to cover the western portion of Bangladesh.

Nepal currently has no 220 kV transmission system. There is a 220 kV transmission system under construction in Nepal in the area surrounding Kathmandu. Initial operation of that system is scheduled for fiscal year 2005. The extension of the 220 kV transmission system in Nepal to the eastern portion of the country is planned for fiscal year 2011-2012.

One of the objectives of this Four Borders Project was to have an interconnection in place as soon as practicable, which was estimated to be in about five years. To insure that the proposed transmission interconnection is useable in that timeframe, the terminus point in Bangladesh would need to be the Ishurdi 220 kV substation. There is no existing 220 kV in Nepal so the interconnection would remain as a 132 kV interconnection.

The proposed new transmission line length for Option B1 (485 km) is almost twice that of Option B2 (275 km). Both of these options are greater distances than proposed in Option A.

Option B has the advantage over Option A in that the energy transfer capability is increased from around 150 MW to up to 500 MW. But the increase only applies for transfers into and out of Bangladesh. Nepal, which has the potential for exporting substantial amount of hydroelectric energy in the next decade, would still be limited by the transfer capability of the proposed 132 kV transmission interconnection.

Options B1and B2 would increase the power transfer capability of the Four Borders interconnection to 500 MW. However, this is higher than the current capability of the regional transmission system.

If Option A focuses too closely on the present situation without due regard for the future development plans of the countries, Option B can be faulted as proposing a solution too far in advance of the generation and transmission system expansion plans of the countries.

3.2.3 Assessment of Option C: Moderate Power Transfer – Phased Development

Option C is proposed to combine the immediate benefits offered in Option A with the scope for future expansion and increased regional trading offered in Option B. Option C achieves the dual benefits through the application of a phased approach.

Phase I of Option C resembles Option A in that the terminus points in Nepal and Bangladesh are at existing 132 kV facilities. The difference is that the proposed transmission line would be constructed for 220 kV operations but initially connected and operated at 132 kV. This would enable the Four Borders project to immediately capture the benefits of increased system reliability and security that come from interconnection.

Phase II of Option C converts the 132 kV transmission line interconnection to a 220 kV transmission line interconnection. This conversion would occur as the transmission systems of Bangladesh and/or Nepal expanded and developed their respective 220 kV transmission systems. The transmission interconnection could also be upgraded from 132 kV to 220 kV as the need for additional transfer capability materialized in Bangladesh and/or Nepal.

Between Option C1 and Option C2, the total constructed transmission line for both phases is the same (275 km). However, Option C1 has less initial construction (140 km) compared with Option C2 (205 km).

Options C1 and C2 provide a phased approach, with an initial transfer capability of 150 MW, expanded to 500 MW when the regional transmission system is able to accommodate this level of power transfer.

The interconnection at 220 kV has a number of additional benefits based on the preliminary power flow analysis conducted for this report. In comparison to the interconnection at 132 kV, the interconnection at 220 kV did not exhibit the low voltage problems. In addition, the interconnection of the four countries at 220 kV improved the system losses. Overall, transmission system losses were reduced by approximately 90 MW. These results are in line with the results from previous power flow analysis by PGCIL during their study of adding an interconnection between India and Bangladesh. When examining the overall system performance with a new 220 kV interconnection with Bangladesh, that PGCIL study also documented a reduction in transmission system losses. Such reductions substantiate the significant benefit of integrated, interconnected operations.

These study results are, by the nature of this pre-feasibility report, still preliminary. Additional system analysis studies such as short circuit studies, stability studies, and voltage collapse studies, and reliability studies would be required to assess potential real system performance.

3.2.4 Assessment of Variations on Options

3.2.4.1 DC Back-to-Back Interconnection

The Eastern Region of India has experienced difficulty operating at a constant frequency as a result of the lack of control over generation facilities and the preponderance of base load, inflexible generating facilities. That is, the amount of energy produced by these plants cannot be easily altered to match changes in demand. This causes the frequency at which electricity is generated to vary upwards from the standard 50 Hz. This can damage equipment and cause other difficulties in operating the system.

Normally the Eastern Region operates in an over-frequency mode, i.e. in excess of 50 Hz. There is concern among some sectors that interconnecting Nepal and Bangladesh to the India/Bhutan grid could introduce similar over-frequency problems in those systems.

Power Grid Corporation of India has analyzed a possible AC synchronous interconnection between the Eastern Region of India and Bangladesh. The conclusions of this study were that the interconnection in this area did not result in stability problems for Bangladesh but rather relieved line loading on the East-West transmission interconnection in Bangladesh. Disturbances in one area, such as the loss of generating or major transmission facilities, can have far reaching affects on interconnected systems. Special relay protection schemes could be developed to mitigate the affects of infrequent disturbances and could be incorporated into the proposed Four Borders Project. However, if the conclusions of the PGCIL's analysis can be verified for the options proposed in this report, the other countries in the region should be assured as to their ability to maintain grid stability within their systems and the need for additional protection devices or DC back-to-back interconnections would be reduced or eliminated.

As an alternative to protection schemes, to insure that the frequency characteristics or disturbances in one area do not affect the other areas, the energy flows over the interconnection can be controlled through the application of a DC bipolar configuration or a DC back-to-back link. The DC bipolar installation is indicated when the transmission line lengths are in excess of around 200 km and the amount of energy being transferred is substantial. DC back-to-back link is more appropriate for shorter distances such as those proposed in the above options.

Technically, the DC back-to-back tie is superior to AC synchronous interconnection for power systems that experience continuing frequency or voltage problems. However in general, a DC back-to-back link is only applied at the 400 kV voltage level where power transfers of 1,000 MW are anticipated. Capital costs for DC interconnections are significant and can be as high as $50 million. Thus the applicability of this alternative to the Four Borders interconnection is not justified due to the limited energy transfer capability of the proposed interconnection.

A back-to-back DC interconnection was found to be too costly for the level of power expected to be transferred through the Four Borders project within the time frame of this analysis.

3.2.4.2 Control Center Location

Locating the control center for the transmission interconnection at a point other than the Siliguri or Purnea substation is another possible variation on the proposed Options. Once again the value of this variation depends on the volume of power traded and the parties to the trades. If all the trades have India as one of the trading parties, India would need to be involved in the scheduling and monitoring of those trades. Locating the primary control facility at a substation outside of India may have appeal for the other countries, but it would not necessarily affect the operation of the interconnection.

At a minimum, each country would need to have the capability to schedule and monitor the trades passing into and out of its control area. Designating one of the control areas as the primary control area and another as the backup or secondary control area is industry best practice and could be applied here. However, clearly defined protocols and procedures regarding scheduling, dispatch, and curtailment of power trades are more important to efficient operation than the physical location of the control center. A well-designed and carefully implemented trading agreement is a requirement for any functional interconnection and is the preferred solution to concerns about the operation and control of a regional interconnection. There is no obvious technical advantage to this variation.

3.2.5 Operational Scenarios

3.2.5.1 Limited Transfer

The level of sophistication with regard to operation of the interconnection is influenced by the type of energy traded, the number of parties involved, the purpose of the energy trades, and the frequency of trades between countries. In addition, a synchronous AC interconnection will require a greater level of communication and protocol than will a DC back-to-back interconnection to insure the same level of reliable system operation.

One of the characteristics of transmission interconnections built primarily to provide security and reliability of supply is the low volume of electricity that is traded during normal conditions in comparison to the capacity of the interconnection. Initially, the proposed interconnection will provide system reliability benefits. As such, the operating protocols could be fairly simple memoranda of understanding between the countries defining each participant's obligations and operating procedures. With regard to economic transfer of energy, operating protocols and administrative terms could be incorporated in bilateral arrangements between the various countries. As trading between the countries increases, there will be a need to develop a common agreement between all parties that defines the terms for access to and usage of the transmission interconnection.

There is no technical constraint to developing protection schemes and communication systems and protocols within the proposed startup time for the Four Borders Project .

3.2.5.2 Multilateral Based Trading Pool

Multilateral-based trading pools, such as have operated in Nordic Pool, the England/Wales pool, and the National Electricity Market of Australia, to name a few, are commercially, legally, and technically more challenging to create than the arrangements discussed above for the Four Borders Region. There is a need to develop a fairly sophisticated level of technical infrastructure within each country to effectively support multilateral trading arrangements.

Developing the specifications for the hardware and software requirements for the scheduling, dispatch, and settlement systems and then procuring those systems is a task that would likely extend the Four Borders Project beyond the proposed startup date. Due to the limited amount of trade expected to take place during the initial years of operation, this level of sophistication is not indicated at this time.

3.2.6 Concluding Observation

The options proposed demonstrate that it is technically possible to have a simple inter-connection project with immediate system reliability and security benefits. These benefits include the emergency exchange of energy following a system outage, the sharing of operating and planning reserves, and the ability to obtain supplemental energy during times of generating facility maintenance outages.

The Four Borders Project also will derive benefits by allowing the countries in the region to take a longer-term view of the supply and demand balance of the region. Increased energy transfers between the countries will provide for diversity of supply sources and reduction of transmission losses. The development of hydroelectric facilities in Bhutan and Nepal over the next decade will result in those two countries being in the position to be net exporters while India and Bangladesh will likely be net importers of electrical energy. While the volumes of trade between the countries are currently small, the potential for greater volumes of trade and larger benefits is evident. The maximum benefit of the Four Borders Project will arise when the proposed transmission interconnection is integrated with the generation and transmission expansion plans of the four countries.

The options analyzed in this report indicate that it is technically feasible to build a regional transmission interconnection in the Four Borders area that would benefit all four countries in the region.

Section 4 Economic Assessment of Options

The purpose of this section is to provide first-order estimates of investment costs for the options discussed previously and to assess the relative economic merit of those options. This preliminary assessment provides only a general indication of the relative economic attractiveness of these alternatives for the Four Borders Project. To assess the full benefits of these options, a complete integrated resource evaluation plan should be conducted as part of a detailed project feasibility study. Such a task is beyond the scope of this preliminary assessment.

4.1 INVESTMENT REQUIREMENTS

In the absence of interconnected systems, the countries in the region have developed system expansion plans based solely on their own resources and requirements. By introducing an interconnection between Bangladesh, Bhutan, India, and Nepal, it will be possible to plan generation and transmission system expansion on a regional basis. Such regional planning will increase system reliability and diversity of supply sources; reduce transmission losses; achieve greater economies of scale; and reduce investment costs as compared with national planning alone. The construction of the Four Borders Project will provide the platform on which to build regional cooperation and planning that will be to the economic benefit of all the countries.

To estimate the investment costs of the proposed interconnection, the data specific to each option were considered, including the costs of the Four Borders substations in Siliguri and Purnea and associated transmission lines. The line costs were based on the lengths of the transmission lines connecting the substations in Bangladesh and Nepal with the Four Borders substations in India, viz., Siliguri and Purnea. In addition, the improvements needed at these substations to accommodate the interconnections also were included. The improvements include the addition of equipment such as buses, circuit breakers, protection relays, communication and related equipment, and civil works as needed.

The costs presented here are preliminary and represent "order-of-magnitude" estimates. They do not have the benefit of a detailed estimate due to the pre-feasibility nature of this study. These estimates are based on various sources, including private communications and discussions with officials of PGCIL, PGCB, Nepal Electricity Authority, and National Grid, as well as information contained in several reports, which are listed in the Bibliography of this report. Based on these preliminary cost estimates, the investment requirements for the various options were estimated. The estimated investment cost for these options ranges from $9.5 million to $52.4 million. Table 4-1 sets out the estimated investment costs for each option.

It can be seen from Table 4-1 that the investment requirements for the proposed Four Borders Project are relatively small. The investment cost for the variation requiring DC back-to-back interconnectors would add approximately $30 to $40 million dollars to total cost, which in most cases is more then the total cost of the option. Given this level of investment, this does not appear to be an economically viable choice.

Table 4-1: Estimated Investment Costs for Options ($ Millions)

Option	Variant 1 (Siliguri)	Variant 2 (Purnea)
Option A: Limited Transfer	Option A1 $ 9.45	Option A2 $14.18
Option B: Moderate Transfer	Option B1 $52.35	Option B2 $27.23
Option C: Phased Development	Option C1	Option C2
Phase I	$16.65	$23.80
Phase II	$14.95	$ 7.80
Total Option C	$31.60	$31.60

The specific factors affecting the investment cost of each option are discussed below, first for those options that locate the Four Borders Project at the Siliguri substation, and then for those options that locate the interconnection at the Purnea substation.

Investment requirements for the Four Borders Project are estimated to range from $9.5 million to $52.4 million, depending on the level of transfer capability.

4.1.1 Variant 1: Connection through the Siliguri Substation

Options A1, B1, and C1 all would locate the Four Borders Project at the Siliguri Substation. Each option is addressed below.

4.1.1.1 Option A1

Option A1 is the simplest interconnection between Nepal, India, and Bangladesh and utilizes existing 132 kV facilities in both Nepal and Bangladesh. In this option, the new transmission line interconnections are all 132 kV. They also connect to the nearest substations (least distance) in Bangladesh and Nepal. As a result, Option A1 is the least-cost option requiring an investment of $9.5 million. However, the power transmission capability of the option is limited to about 150 MW.

4.1.1.2 Option B1

Option B1 utilizes the existing 220 kV facilities at Ishurdi substation in Bangladesh. It requires a long (435 km) 220 kV interconnection to connect Siliguri with Ishurdi. As a result, Option B1 is the highest cost option requiring an investment of $52.35 million. However, such an arrangement would allow for greater transfer of electrical energy into Bangladesh – up to about 500 MW. Since there is no 220 kV line in Nepal, it is connected with a 132 kV line and power transfer with Nepal would remain limited to about 150 MW.

4.1.1.3 Option C1

Option C1 is a phased approach to development of the proposed interconnection. In Phase I of this option, 220 kV lines are built from Siliguri to Thakurgaon in Bangladesh and from Siliguri to Anarmani in Nepal. However, the interconnection is operated at 132 kV with power transfer capability limited to 150 MW. In Phase II, the additional 220 kV transmission lines are built as and when the transmission systems of Bangladesh and Nepal expand and develop their respective 220 kV transmission systems. These additional lines are: (i) from

Thakurgaon to Barapukuria in Bangladesh and (ii) from Anarmani to Duhabi in Nepal. The entire operation is then converted to a 220 kV system. At this point this option also would allow the transfer of up to 500 MW.

Option C1 offers several advantages. The first advantage is that in the long-term it allows for a higher level of power transfer, up to about 500 MW, while in the near-term power transfer can take place at a lower level, up to about 150 MW. Secondly, it can be built in two stages with an initial investment of $16.65 million in Phase I. Phase II can be built at an incremental cost of $14.9 million. The total cost of this option is $31.6 million. The overall cost of this option is much less than that of Option B1, which also allows for the higher level of power transfer.

4.1.2 Variant 2: Connection through Purnea

Options A2, B2, and C2 all would locate the Four Borders interconnection at the Purnea substation. Each of these options is addressed below.

4.1.2.1 Option A2

In this variation, the 220/400 kV substation at Siliguri is substituted by the 220/400 kV substation at Purnea as the interconnection point in India. Option A2, would cost an estimated $14.18 million, which requires about $4.7 million additional investment over Option A1, and does not offer any additional economic or technical advantage.

4.1.2.2 Option B2

This option offers the same advantages as Option B1, but at a lower investment cost of $27 million. In this option, the 220/400 kV substation at Purnea connects with the 230 kV substation at Ishurdi. Thus Option B2 is the least cost option that also allows for the higher level of energy transfer into Bangladesh – up to about 500 MW. The energy transfer into Nepal, however, is at the lower level of up to about 150 MW (due to local transmission constraints).

4.1.2.3 Option C2

Option C2 offers similar advantages as Option C1 but at a higher Phase I investment cost. Its Phase I investment cost is $ 23.8 million, while Phase II can be built at an incremental cost of $7.8 million. The total cost of Option C2 is the same as that for Option C1.

The relative advantages and disadvantages of the Options are compared in Table 4-2.

Table 4-2: Relative Advantages and Disadvantages of the Options

Options	Four Borders Substation At	Advantages	Disadvantages
A1	Siliguri	Least cost	Low power transfer capability, up to 150 MW
A2	Purnea	Higher cost than A1	Low power transfer capability, up to 150 MW
B1	Siliguri	High power transfer capability, up to 500 MW	Highest cost
B2	Purnea	High power transfer capability, up to 500 MW	High cost but much less than B1
C1 Phase I Phase II	Siliguri	 Low initial cost Low incremental cost. High power transfer capability, up to 500 MW	 Low initial power transfer capability, up to 150 MW
C2 Phase I Phase II	Purnea	 Incremental cost lower than C1. High power transfer capability, up to 500 MW	 Initial cost higher than C1. Low initial power transfer capability, up to 150 MW

4.2 ECONOMIC ASSESSMENT OF THE OPTIONS

To decide upon a recommended option for the proposed Four Borders Project, the relative economic attractiveness of the options needs to be evaluated. For this purpose, the two lowest cost options of those analyzed above were selected and evaluated based on two commonly used approaches.

The first approach—the Levelized Transmission Cost—estimates the cost per kWh of power transmitted through the Four Borders interconnection that is necessary to recover the investment costs of each option, plus provide an adequate return on the investment. The second approach—the Internal Rate of Return—estimates the percentage return on investment for each option as an indication of the relative profitability of the investment. For this type of project, if the estimated Internal Rate of Return is above the threshold percentage deemed necessary to justify the investment (which in this case is estimated to be 14%), then the investment is judged to be worthy of serious consideration. The higher the Internal Rate of Return the more financially attractive the investment.

The following economic/financial parameters are used as input for the economic assessment of each of the options:

- Debt/equity ratio 70/30
- Debt interest rate 13.5%
- Return on equity 16%
- Construction duration 3 years
- Loan term 9 years (post construction)

- Depreciable life 25 years
- Insurance 0.25% (on undepreciated assets)
- Working capital 1%
- Annual escalation 2% on capital cost
  10% on O&M cost
- Startup year 2005

4.2.1 Levelized Transmission Cost

The levelized transmission cost provides one approach to assessing the relative merit of a project by looking at the fully burdened project cost on an annualized basis. Accordingly, based on this approach the levelized cost of the investments ranges from $1.3 million per year to $6.7 million per year. Year 2000 costs are used to derive these estimates as the data available are based on the year 2000. Figure 4-1 sets out the estimated levelized costs for each option.

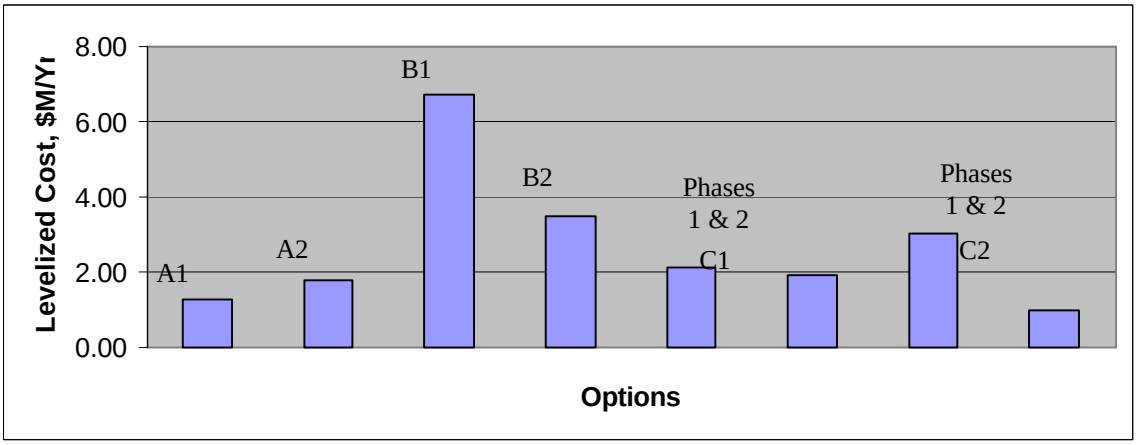


Figure 4-1: Levelized Costs for Each Option

Based on the above data, the levelized cost of transmission was calculated for various levels of throughput for Option B2 (Purnea) and Option C1 (Siliguri). These options were selected because they represent the two lowest cost options for the Four Borders Project that also provide for the higher level (500 MW) of power transfer capability.

Table 4-3 sets out the results of this analysis.

Table 4-3: Levelized Transmission Costs (cents/kWh)

Power Level	Option B2	Option C1 Phase I (Initial)	Option C1 Phase I + Phase II (final)
50 MW	2.24	1.36	2.60
150 MW	0.75	0.45	0.87
300 MW	0,37	--	0.43
500 MW	0.22	--	0.26

The transmission costs for the preferred options vary from 2.6 cents/kWh to 0.22 cents/kWh, and reduce substantially with the amount of power transferred.

As shown in the above table the levelized cost of transmission declines significantly as the level of power transferred through the interconnection increases. Comparing the two options, Option C1 provides lower transmission costs in Phase I that would be more consistent with the initial smaller volumes of power to be transferred. In Phase II the transmission costs are comparable to those of Option B2.

4.2.2 Assessment Based on Internal Rate of Return

The Internal Rate of Return of an investment is a commonly used method of assessing economic viability. This method hinges on the idea that for a project to be economically attractive, the Internal Rate of Return must be at least equal to the effective discount rate. The effective discount rate is the combined financing rate of debt interest rate and return on equity needed to justify the investment. The two important parameters needed for estimating Internal Rate of Return for these options are the net present value (NPV) of the investment and the stream of annual earnings from transmission charges. The NPV includes all the costs incurred throughout the life of the project, such as interest on loan, depreciation, and operation & maintenance costs.

For this assessment, Option B2 and Option C1 are again analyzed. Option B2 is used as a reference case because it has the lowest relative investment cost and yet would be capable of transferring up to 500 MW capacity. The Internal Rate of Return for alternate levels of power transfer at different assumed levels of transmission prices was then estimated based on information obtained from various sources, including PGCIL and PGCB. The estimated Internal Rate of Return for Option C1 is then compared to this reference option.

Two methods of transmission charging are practiced in the Four Borders countries: the embedded cost method and the incremental cost method. In the embedded cost method, all users are charged a flat rate (fixed cent/kWh) irrespective of the quantity of power transferred or the transmission distance. In the incremental cost method, users are charged generally on the basis of transmission distance. For the purposes of this initial assessment, the embedded cost approach was used to facilitate a system-wide comparison.

In Section 4 it was noted that this proposed Four Borders Project would rely on existing facilities as much as possible and would use existing transmission facilities that are part of the India grid. Therefore, a wheeling charge for the use of these facilities should be incorporated in the costs of this project. An estimate of this charge was developed based on discussions with PGCIL.

PGCIL currently is considering a wheeling charge on the order of 0.65 cents/kWh for transferring power from Bhutan to Siliguri, with an escalation rate of 7 to 10 percent per year. Therefore, this charge is included in the cost analysis for the Four Borders Project and is used

to estimate the stream of expenses throughout the life of the project (using an escalation rate of 7 percent).

Likewise, the stream of earnings for the project includes revenue derived from the wheeling charge, which consists of two components. One is the charge for using existing facilities in India. The other is the charge for use of the new Four Borders facilities. These charges are combined into one wheeling rate and are passed on to the exporters as an embedded charge.

To estimate the potential Internal Rate of Return at different wheeling rates for the Four Borders Project, the combined cost of transmission was varied from 1.0 cents/kWh to 1.2 cents/kWh. This includes the estimated 0.65 cents/kWh for the Indian facilities and a wheeling charge rate for the new facilities varied from 0.35 cents/kWh to 0.55 cents/kWh. This range of wheeling rates is used to estimate an indicative range of Internal Rates of Return.

Finally, in considering the Internal Rate of Return analysis the calculated returns should be compared to the project cost of capital (hurdle rate), which has been estimated to be approximately 14 percent. Accordingly any Internal Rate of Return below this level may not be attractive to private developers.

The steps involved in estimating the IRRs for a situation include:

For the embedded cost method, the transmission distance does not enter into the calculations. A flat charge (cents/kWh) is used. The charge is also independent of the source and destination of power transfer. The receiving country pays the charge.

1. First, the hurdle rate is calculated using the debt interest rate and return on equity

2. For a given option, say Option B2, the net present value (NPV) of the stream of all annual expenses is calculated. These expenses include: interest on loan, return on equity, depreciation, O&M, insurance, and property and income taxes.

3. For a given level of power transfer, say 150 MW, total kWh dispatched during a year is calculated

4. For a given transmission charge rate, say 0.35 cents/kWh, plus 0.65 cents/kWh wheeling charge, the NPV of the stream of annual revenues of transferring the above kWh for the next 25 years is calculated

5. The IRR is the interest rate (rate of return from the annual revenues), which makes the "NPV of all the revenues of step 4" equal to the "NPV of all the expenses of step 2". The computer program calculates the NPV of the stream of revenues in step 4 with progressively incremental values of interest rate until it finds the interest rate that makes the two NPVs equal. This interest rate is the breakeven rate, which determines the viability of a project.

6. The step 5 is repeated for all the options (B2, C1 – phases 1 & 2), for all levels of power transfer (50, 150, 300, 500 MW), and for three transmission charge rates (0.35, 0.45, 0.55 cents/kWh)

The results of the analysis are presented in the Tables 4-4, 4-5 and 4-6 (Internal Rate of Return %).

Table 4-4: Internal Rates of Return Based on Embedded Transmission Costs – Option B2

Estimated Transmission Charge Rate, cents/kWh			
Power Transfer	**1.0**	**1.1**	**1.2**
50 MW	10%	10%	11%
150 MW	15%	15%	16%
300 MW	17%	18%	19%
500 MW	18%	19%	20%

Table 4-5: Internal Rates of Return Based on Embedded Transmission Costs – Option C1; Phase I

Estimated Transmission Charge Rate, cents/kWh			
Power Transfer	**1.0**	**1.1**	**1.2**
50 MW	12%	13%	14%
150 MW	16%	17%	18%
300 MW	--	--	--
500 MW	--	--	--

Table 4-6: Internal Rates of Return Based on Embedded Transmission Costs – Option C1; Phase I and II

Estimated Transmission Charge Rate, cents/kWh			
Power Transfer	**1.0**	**1.1**	**1.2**
50 MW	9%	10%	10%
150 MW	14%	15%	16%
300 MW	16%	17%	18%
500 MW	18%	19%	19%

Based on the above analysis, the following observations can be made:

- The estimated Internal Rates of Return are positive for all options at all levels of throughput.
- At the 150 MW level of transfer, the estimated Internal Rates of Return increase significantly and meet or exceed the hurdle rate for investment (14%).
- The phasing of investment in Option C1 would provide higher initial Internal Rates of Return than Option B2.

An analysis of the preferred options shows that the phased approach to developing the Four Borders Project better matches costs and benefits and provides a higher initial return on investment, which increases with the level of power transfer.

4.3 CONCLUSIONS

The following can be concluded from the above analysis:

- The investment requirements for an interconnected system are relatively small and should not present a significant barrier to development of the proposed Four Borders interconnection.
- It does not appear that DC back-to-back interconnectors would be economically viable given the investment requirements and anticipated levels of throughput.
- For the range of transmission prices assumed, all of the options analyzed have positive Internal Rates of Return.
- The relative economic merit of the options increases significantly with the amount of power transferred through the interconnection.
- Option C1 provides both lower levelized transmission costs and higher initial returns due to the phasing of investment. This makes this option a more attractive path for development. On this basis, Option C1 is the recommended option for the proposed Four Borders interconnection.

Based on this analysis, Option C1 is the most attractive option for a Four Borders Interconnection concept.

Section 5 Legal/Regulatory and Financial/Commercial Considerations

This section identifies the regulatory and financial structures that would facilitate development, ownership, and operation of the proposed Four Borders Project. This discussion also relates lessons learned from countries in other regions, defines principles for success and examines the regulatory and commercial considerations germane to the proposed regional interconnections.

5.1 OTHER REGIONAL EXPERIENCE – LESSONS LEARNED

In addition to the countries involved in the SARI/Energy Project, countries in many other regions of the world are engaged in efforts to promote cooperation and trade in electric power. The underlying issues involved in these efforts are similar to those currently being addressed by the SARI/Energy Project, and the experiences and lessons learned from other regional activities have important relevance to the South Asia region.

Cross-border interconnections in other regions, including Southern Africa and South America, can provide useful "lessons learned" for the Four Borders Project.

Although there are a number of ongoing efforts to develop regional power trading regimes throughout the world, efforts in three regions have particular relevance to South Asia: (1) the Southern Africa Power Pool (SAPP); (2) the Nord Pool; and (3) the Commission of Regional Power Integration (CIER). Detailed information on system interconnections in these and other regions is provided in Appendix A of this report.

5.1.1 Southern African Power Pool (SAPP)

The SAPP was created in 1997 by the twelve countries (each a "Member") that comprise the Southern African Development Community (SADC). The purpose of SAPP is to promote regional interconnection and trade in electric power among participating Members and to provide a reliable and economical electricity supply in a manner consistent with the efficient use of natural resources and minimum impact on the environment. SAPP's primary objectives include:

- Coordinate the planning and development of interconnections between Members;
- Reduce investments and operating costs, enhance reliability of supply, and share benefits of coordinated planning and operation;
- Coordinate the planning, development, and operation of generation and transmission facilities with minimum impact on the environment; and
- Cooperate and seek mutually beneficial arrangements for Members and avoid arrangements that would be detrimental to any member.

SAPP countries have a diverse mix of hydro and thermal power generation plants and a service area of nine million square kilometers with a population of over two hundred million people. All participating Members are signatories to several agreements, including an Inter-Utility Memorandum of Understanding whereby the national utilities have agreed to adhere

to common standards, requirements, and procedures and to participate in the creation and operation of a regional power pool through various committees. There are two categories of membership: (1) *Operating Members* are national utilities (restricted to one per country) designated by the country's government that are interconnected with at least one other member utility (Operating Members participate in all SAPP activities); and (2) *Non-Operating Members* are additional members from each SAPP country that participate in all activities except those related to the operation of the power pool.

SAPP's organizational structure includes a number of entities that provide leadership, establish and implement policy, develop technical and operating standards, monitor the day-to-day operations of SAPP, and establish environmental guidelines. SAPP also has a coordination center located in Harare, Zimbabwe, which performs a number of functions to monitor the day-to-day operations of SAPP, collects data and develops reports and planning studies, and disseminates information to members and engages in training activities.

A study of the potential benefits of SAPP conducted by the SADC found potential savings from SAPP, as compared with each member country pursuing energy self-sufficiency, of $785 million (1992 US$) or 20% of total costs for the period 1995-2010.

5.1.2 Nordel/Nord Pool

The Nordic countries have a long history of regional cooperation in the electricity sector, although they have a wide variation in ownership and regulatory structures. Since 1963, the power sectors in these countries have worked together to promote the efficient supply and use of electricity, reduce environmental impacts, and provide low-cost, reliable service to consumers. A major impetus for this cooperation was to take advantage of the varying resource base, consisting of both thermal- and hydro-based systems, of the Nordic region.

The Nordic countries created the world's first international power pool between Norway and Sweden in 1996. Trading in electric power between the countries was enabled by Nordel, an organization established in the 1960s to promote cooperation among the largest electricity producers in each country. The purpose of Nordel is to provide advice and recommendations that would promote a more efficient electric power system in the Nordic region, taking into account the conditions prevailing in each country. Nordel also seeks to further international cooperation and provide public information on issues pertaining to the regional electric power market.

Power sector reforms, which began in Norway in 1991, led to the creation of a spot market for electricity in 1992. However, because all of Norway's generation is hydro-based, the spot market price was very volatile. This let to the creation of a combined Norway/Sweden market in 1996, which was designed to reduce price volatility as well as mitigate the market power of Sweden's two primary power suppliers. Finland joined this combined market in June 1998 and Denmark in 1999. Nord Pool is owned by the two national grid companies in Norway (Statnett SF) and Sweden (Svenska Kraftnat). The other national grid companies in member countries are also expected to become owners of Nord Pool.

Nord Pool's major activities include *Elsopt*, the Pool's spot market with physical delivery of power; *Eltermin*, its financial market for futures and forward contracts with a time horizon of up to four years; and *Elclearing*, its clearing service by which Nord Pool clears all contracts traded on the power exchange.

A mix of companies participates in Nord Pool, from large government-owned utilities to privately and municipally owned systems of varying size. However, as the system has evolved, ownership of the transmission systems and cross-border interconnections has been shifted to a national grid company in each of the countries. This has helped ensure open access to all pool members and mitigated the market power of large participants.

5.1.3 CIER

The Commission of Regional Power Integration, known as CIER by its Spanish language acronym, is an association of the major power producers in both the public and private sectors of South America. CIER became operational in 1965 as a mechanism to promote regional cooperation and integration of electric power systems in South America.

CIER is a nongovernmental organization, comprised of the electric utilities and nonprofit organizations involved in the South American electric power sector in Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, and Venezuela. CIER also has six associate electric utility members from Mexico, France, Spain, Portugal, the United Kingdom, and Sweden.

Each member country of CIER is represented by a National Committee composed of electric generating, transmission and distribution companies and nonprofit entities (public and private) associated with each national power sector. CIER maintains close contact and cooperation with national regulatory entities and energy ministries throughout South America.

CIER is primarily a technical organization, which collects data and information and performs studies and analyses related to the operation and integration of electric power systems. While focusing primarily on technical issues, these activities also involve related policy, legal, and regulatory issues.

CIER’s major policy making body is the Central Committee, which is comprised of a maximum of three delegates from each National Committee. This body approves CIER’s annual budget and develops policies and priorities for CIER, including approving technical studies and other activities for the benefit of its members. CIER also has a number of working groups, which address specific issues related to the electric power sector. CIER also provides statistical information and produces on a regular basis various publications and reports addressing technical and related operational issues.

CIER's major functions are to promote regional cooperation, development of integrated electricity systems, and cross-border interconnections among member countries. South America has a regionally diverse mix of energy resources, including hydroelectric in the north and thermal resources (particularly natural gas) in the south. This resource diversity contributes to significant cost differences in supplying electric power and to short-term price instability for hydro-based systems. These opportunities for trade are a major force in determining activities by CIER to promote regional cooperation and integration of power systems. CIER has been instrumental in promoting cross-border interconnections between several member countries.

5.1.4 Common Characteristics and Lessons Learned

These efforts in other regions to create international power pooling mechanisms have several common characteristics that are relevant to promoting regional energy trade and cooperation in the Four Borders Region of South Asia, including:

- A diverse resource base, consisting of hydro- and thermal-based generation that provides opportunities for significant benefits from regional power trade;
- Significant differences in short-term production costs and availability of supplies that also provide opportunities for trade;
- Major domestic reform efforts underway within individual countries in the region that contribute to the ability of individual power systems to engage in regional coordination and trading activities; and
- Interest and participation by a diverse group of power market participants in promoting and developing greater regional interconnections and trade.

Power trading mechanisms of other developing countries have several characteristics in common with the Four Borders project: (1) a diverse resource base with hydro- and thermal-based generation; (2) significant differences in short-term production costs; and (3) major domestic reform programs in individual countries that could support cross-border trade

Lessons learned by these regional power systems that apply to the Four Borders Region include:

- A sustained and high-level of political support is needed to promote regional cooperation and energy trade.
- A regional coordinating body is needed to develop the necessary protocols to support increased energy trade.
- Power sector structure and reform efforts in individual countries within a region do not need to be identical or move at the same pace in order to support significant advances in regional cooperation and cross-border trade. However, reform policies and programs need to be compatible and need to take into account the broader regional perspective.
- A consistent and developed transmission policy is needed based on operating and pricing protocols that ensure open access and safe, reliable, and efficient operation of the regional transmission system.
- There must be coordination and information sharing among regional power sector participants to support power trades and long-term planning for the generation and transmission segments of the power sector.

5.2 PRINCIPLES FOR SUCCESSFUL CROSS-BORDER POWER TRADE

Based on the preceding examples and other international experience, the World Bank and others have established that successful regional power trade depends on extending the

legislative and regulatory frameworks that have been developed to meet domestic demand and effectively adapting them to provide for cross-border transmission interconnections. These interconnections must have rationalized transmission tariffs, open transmission access, compatible grid codes, and common market rules that govern buyers and sellers in different countries.

Regional power trade and transfer involves three levels of international coordination:

1. Coordination among national energy policies through a Government Representative (usually a Ministry of Power);
2. Coordination among national transmission system operators (TSOs) and among national energy regulators. Such regional coordination should be based on principles of cooperation and mutual benefit and supported by rules for: (i) protection of grid stability; (ii) definition of access rights to transmission networks, including selection of methods of managing congestion and responsibility for planning and investments in new interconnections;
3. Network service tariffs (payments among TSOs and payments by transmission system users to TSOs).

5.3 LEGAL/REGULATORY CONSIDERATIONS

Presently, the regulatory process in South Asia does not provide for considering the utility planning of other countries in the region. Individual countries do not assess or compare plans of other countries in the region to ensure that their plans are consistent and meet the combined needs of the region. Nor do National and State utilities fully consider the sources of power (or revenues) outside their national service territory as potential sales or purchases of power.

In South Asia, the principal precursor to the SARI/E project is the previous effort to develop regional energy policies through SAARC. Multilateral initiatives have been traced back to the August 1998 Dhaka workshop "Improving the Availability of Power in South Asia: Search for Optimal Technology Options" (Federation of Engineering Institutions of South and Central Asia) at which the Dhaka Declaration proposed the creation of a SAARC Power Grid. However, for various political reasons (principally involving unrelated disputes between the member states of India and Pakistan), SAARC has been unable to follow through and develop regional power trading initiatives. While the Dhaka workshop was supported by subsequent efforts initiated by the World Bank and Asian Development Bank, serious efforts to promote regional energy cooperation in South Asia have not progressed.

To succeed, the proposed Four Borders project will need sustained support from regional policy makers and other stakeholders.

5.3.1 Existing Regional Power Trade

Without regional interconnections, there has only been limited bilateral power transfer and trade in the Four Borders Region. For example, the 1996 Treaty of Mahakali between Nepal and India was developed primarily for sharing of water resources, but it also governs the joint

development of the Pancheshwar project on the Mahakali River. It contains no commercial terms, only the provision that a portion of Nepal's power would be sold to India based on prices to be agreed upon later. Similarly, the 1997 Power Trade Agreement, which has yet to be ratified by Nepal, only states that "specific terms and conditions of contract to be determined by the parties." However, this agreement, if ratified and implemented, would provide for private parties in either country to develop and trade power across border.

Agreements on pricing terms and conditions that had been set by the Kosi Agreement in 1972 have been increased since 1994 through negotiations of the Power Exchange Committee established in 1992 such that power transfer is planned to increase to 150 MW. However, at the same time, efforts to increase power trade through IPPs in Nepal, such as the West Seti hydro project, remain stalled over disputes regarding the tariff that would be paid by Power Trading Corporation of India (PTC).

Similarly, only limited power trade presently exists between India and Bhutan, primarily through the 350 MW Chukka Hydro Project, which was developed on a government-to-government basis with grants (60%) and soft loans provided by the Government of India. Although a substantial increase in power trade will be provided by the Tala hydro project (1,020 MW), also heavily subsidized by India, a recent effort to utilize private investment to build the dedicated transmission line has been unsuccessful because of the relatively low investor return offered by PTC.

Currently, Bangladesh has no existing agreements or instruments for transfer or trade of power. However, in 1998, the National Thermal Power Corporation of India (NTPC) proposed a joint venture with the Bangladesh Power Development Board (BPDB) to establish a 1,000 MW gas-fired combined cycle project. A joint committee of representatives from both governments was formed to evaluate the proposal, but the project was not developed. Nonetheless, in September 2000, a prefeasibility study prepared for the Government of Bangladesh with the support of USAID confirmed the viability of a 750 MW power export project situated in western Bangladesh that could be developed by 2005 with 375 MW of capacity exported to India.

5.3.2 Prospective Legal and Regulatory Needs

In the absence of predictable legal, regulatory, and trade frameworks in South Asia, present conditions for power trade are manifested by: (i) cumbersome regulatory processes that lengthen the time for governments and investors to make decisions; (ii) unclear and fluid regulations and requirements; (iii) approvals and authorizations that must go to the highest levels of government; (iv) policies and regulations that change arbitrarily and/or frequently; and (v) discriminatory treatment in the application of laws, regulations, taxes, and required technical or operational standards.

To support development of regional power trade, legal structures are needed in each country that provide a basis for the development of facilities dedicated to cross-border trade. Legal support is needed for:

- Generation projects intended to provide power for cross-border trade and transfer;
    - Dedicated transmission and distribution facilities to support power exports;

- Creation and enforcement of contracts for cross-border trade based on commercial terms and conditions;
- Creation and transfer of security interests in project assets;
- Taxation of property and earnings of cross-border projects; and
- Eminent domain or expropriation of land needed for transmission rights-of-way.

Similarly, legal regimes need to be supported by power trading regimes that:

- Allow participants to understand what governments expect them to do;
- Allow participants to understand what they can expect governments to do;
- Provide participants comfort that, once established, these regimes will not be arbitrarily changed, thereby protecting the investment and reducing perceived risk.

Moreover, institutions within the region to support power sector reforms and cross-border trade are either weak or nonexistent. No country in the region has existing institutions with the explicit authority and committed resources to undertake cross-border power trade. The closest such authority is PTC, which has been given, through the Indian government's approval of its Articles of Association, the authority to represent the interests of the public and private buyers and sellers of cross-border power.

To support development of regional power trade, the legal, commercial and regulatory regimes of each of the four countries need to be strengthened.

To achieve regional power trade and transfer, the following measures to strengthen power sector institutions should be undertaken in each country in the Four Borders Region:

- **Designation of Available Power Surplus**: As demonstrated by the stalemate over the export of gas from Bangladesh, regional power trade will not be supported if it competes with domestic needs. For this reason, other developing countries that have enacted legal authority for exporting surplus power have designated a nodal government agency for making the initial determination that sufficient power exists to meet domestic demand and establishing how much power is available for export (which is updated periodically).
- **Nodal Agency Designation to Support Cross-Border Trade**: All regional countries need to establish a nodal entity, similar to India's Power Trading Corporation Ltd. (PTC) and its stakeholder, Power Grid Corporation of India Ltd. (PGCIL), to help support and develop projects for cross-border power trade and transfer through licensing, joint ventures, and other arrangements involving the private sector.
- **Designation of an Independent Regulator**: A cornerstone to regional trade in South Asia is the creation of a strong, independent regulator of cross-border transactions. The role of the regulator is to ensure full access to the transmission system to promote competitive markets and economic efficiency and to ensure that suppliers with access to purchase options are protected against monopoly power. An autonomous regulator with independent decision-making powers, and the power to enforce regulations, ensures that private and public participants are treated on an equal basis. While each country in the region is addressing the need for an independent regulator for its power sector, there is no

evidence that this new entity would have the authority to oversee cross-border trade in electric power.

5.3.3 Considerations Related to a Phased Approach for Project Development

In Section 4, various options were discussed that basically define the concept for the proposed Four Borders Project. Options C1 and C2 reviewed in Section 4 presented a phased approach to development of the proposed interconnection. This phased approach would meet the short-term requirements for improving technical stability and providing a basis for limited power transfer, and it also would begin to address the longer term potential for regional power trade. The legal/regulatory considerations for each phase are addressed in the following:

- **Phase I (Power Transfer):** This report establishes the viability of providing regional power transfer for up to 500 MW in the Four Borders Region. This limited increase in power transfer capability could be readily implemented by expanding the scope and role of the Power Exchange Committee between India and Nepal so that it becomes a truly regional entity with the addition of Bhutan and Bangladesh. To do so, a Memorandum of Understanding, signed by concerned parties in Bangladesh, Bhutan, India, and Nepal, could be executed that builds upon the original terms of reference that were established for the India-Nepal Power Exchange Committee in 1992 and considers the salient principles of the Power Trade Agreement executed by India and Nepal in 1997.

  The Terms of Reference of the India-Nepal Power Exchange Committee are to:

  - Examine the adequacy of existing transmission links between countries and propose additional links;
  - Examine the means for implementing and funding of additional transmission links;
  - Monitor progress of transmission links under construction and relate to proposed additional links;
  - Examine existing tariffs in relation to actual cost of generation and transmission; and
  - Recommend principles applicable to power trade and transfer that promote an integrated and optimal operation of the different systems for long-term power supply (>5 years), temporary power supply (<3 years), seasonal power supply, emergency power supply (due to breakdown of generation plants/transmission facilities, and restricted power supply (peak and off-peak).

  The India-Nepal Power Trade Agreement also establishes that:

  - Any governmental, semi-governmental, or private enterprise may enter into a power trade agreement;
  - Specific terms and conditions of any contract is to be determined by the parties;
  - Respective governments shall provide assistance and facilitate such agreements;
  - Parties will receive all incentives and concessions available under relevant laws; and
  - Power trade agreements between generators and third parties are not precluded;

- **Phase II (Power Trade):** With additional transmission capacity beyond what would be provided by Phase I of the Four Borders project, it would be possible to expand from limited power transfer to phased increases in power trade. This could be implemented by drawing upon the lessons learned in other regions. These might include:
  - *Inter-Utility Agreements (SAPP Model):* A working committee mechanism could subsequently be more formally organized through an Inter-Utility Memorandum of Understanding, similar to what was done by SAPP. The Inter-Utility Memorandum of Understanding developed by SAPP establishes the basic operating principles for coordination and cooperation in planning and the operation of the member systems so as to minimize costs while maintaining reliability in order to provide for full cost recovery and equitable sharing of benefits (i.e. reductions in required generation capacity and fuel costs; improved utilization of hydropower resources).
  - *Regional Power Trade Treaty (Central America Model):* Eventually, governments might consider a formal regional organization created by treaty, whereby each country designates a regional power market agent, similar to the recent treaty agreement among Central American countries.
- **Future Legal/Regulatory Considerations:** By implementing a limited increase in regional power transfer capability through the proposed cross-border interconnection, a sound basis can be developed for organizing and developing trading regimes involving substantial power trade in the region. This is contemplated by the draft Electricity Bill for India, which would introduce several other new concepts in comprehensive, recodified legislation that provides financial independence for regulatory authorities, focuses on distribution, treats electricity as a commodity and promotes state energy board (SEB) restructuring. Bangladesh also has developed a draft electricity bill that would provide for an independent regulator and well as other legal and regulatory provisions to support power sector restructuring. This bill should include explicit authority for the regulator to support cross-border trade in electricity.

5.4 FINANCIAL/COMMERCIAL CONSIDERATIONS

The economic review contained in Section 4 of this report concludes that a regional interconnection would cost between $10 million and $52 million. These amounts could be supported within existing budgets of power sector entities in the region, with or without the funding assistance of multilateral banks such as Asian Development Bank and the World Bank, which have long supported regional cooperation. Other than providing for the capital investment for the proposed Phase I regional interconnections, a principal issue involves whether or not to impose wheeling charges on the limited power transfer transactions (in India, this amounts to 10 paisa per kWh).

For Phase I of the recommended option, there is need to agree upon a transmission tariff for power transferred through the proposed Four Borders interconnection. A typical approach that is often used to initiate regional power trade and transfer is to disarm the pricing issue by adopting either of two methods:

- **No Compensation but Payment in Kind** (recipient provides similar transmission services at a later date so that wheeling costs even out);
- **Split-the-Savings** (the wheeling utility is allowed to share in the savings of the transaction, e.g., 15-35%);

For Phase II of the recommended option, where the ability to trade power through the interconnection is expanded, consideration should be given to examining the full range of available ownership and transmission pricing options and the various means that have been employed to involve the private sector on commercial terms. Appendix B reviews in detail the principal commercial instruments and agreements relevant to regional power transactions.

5.4.1 Ownership Options

The development of utilities within the region with separate and distinct service territories has led to transmission lines that reflect the limits of the utilities' boundaries. The current system of ownership generally has not promoted building larger lines for use by multiple utilities, especially for meeting power demand sales based on a line configuration that optimizes the usefulness of the overall system.

Phase I regional interconnections for the Four Borders Project would require modest capital investment that could be supported by the public sector (with or without multilateral donor/lender support). Accordingly, the initial regional interconnections that have been proposed could be developed without involving the private sector to finance the regional interconnections on a commercial basis. However, to provide for regional power trade under Phase II, a new ownership approach is in order that does involve the private sector and relies on newly created cross-border power markets.

Cross-border projects can be developed as government-to-government projects, as IPP projects or by a public-private joint venture. As power export projects, the primary interest is to generate additional foreign exchange that serves as a source of revenue for the public benefit. Hence, a power export project might best be structured as a joint venture, in order to generate an additional source of trade income that is available for public purposes. Such project development options include:

- **Ownership by Unbundled Public Utility Holding Companies:** Holding company utility systems consist of separate (unbundled) utilities under the control of a single holding company. Typically, the system has interconnected generating, transmission, and distribution systems that operate on a highly coordinated basis as a single system with central dispatch (similar to a tight power pool); otherwise, a holding company can have utilities that are not interconnected as a single, integrated system but that operate as part of a larger power pool with other utilities through agreements that provide for common operation of facilities and joint planning of system expansion.
- **Joint Ownership:** Inter-utility bulk power transactions can also be conducted through joint ownership of generation or transmission systems (often through a special purpose company) to spread the cost and risks of new, larger facilities. In such schemes, one utility is designated as the operator, and power allocations to each of the members are regarded as bulk sales from the central operator. Otherwise, a separate entity may be created to own and operate the shared facilities. Each member is a shareholder in the new entity and transactions are treated separately, similar to transactions between utilities in a holding company.

  Joint ownership of transmission utilities allows for solutions to problems faced by individual utilities, such as opening up bulk power sales opportunities by eliminating a bottleneck (especially during peak periods) that is located outside the individual utilities' service and planning areas. Inter-utility bulk sales are often limited because of unintended

loop flows caused by lines owned by a third transmission utility. When utilities build additional capacity within their service areas they commit to incurring all project costs, knowing that their use of the lines will be restricted by unintended power flows from other utilities. Since the capacity is used without compensation, utilities are faced with enhancing their own lines at their own expense to facilitate sales of other utilities. In such cases, joint ownership is the most cost-effective and appropriate approach for eliminating bottlenecks with increases in transmission capacity.

- **Third-party Ownership**: Another ownership option involves inter-utility bulk power sales from generating and transmission facilities owned by independent, third parties, usually in the private sector. In addition to IPPs that have been established in each of the SARI countries, private third-party ownership in India has been extended to transmission and distribution and is now being pursued by PGCIL for grid expansion.

  PGCIL has identified projects worth 89,000 crores over the next 12 years with 18,500 crores to be provided by private sector licensees and the remainder to joint ventures where Power Grid will hold 26% equity. In a recent solicitation, as an alternative to joint venture projects, Power Grid has identified eight transmission systems that would be developed entirely by the private sector on a build-own-operate transfer (BOOT) basis at a cost of $2.62 billion. These projects would evacuate power from certain mega-projects, help develop a national grid for interregional power transfers, and transfer surplus power from the Northeastern region.

5.4.2 Commercial Terms and Conditions

To provide for regional power trade as envisioned under Phase II of the recommended option, power trading should be carried out on a commercial basis with the private sector. To do so, regional power trading will need to overcome many of the same barriers in the region that have limited private sector investment in national generation and transmission projects.

For example, project developers will want to establish the need for the project, the ability to construct and operate the project, and, for gas-fired projects that also include cross-border trade, the ability to secure firm, long-term gas supply. Developers need to know all of the criteria they must satisfy to attract private investors, and they need to know that, upon compliance, their request for approval will receive prompt and efficient attention. Moreover, private investors need to know that, through sufficient training, regulatory authorities and other government officials are qualified to evaluate export projects and are able to assist developers through the development and approval process.

Cross-border projects using clean fuels will compete with different fuels in different markets. Private developers need to know that the natural gas or hydropower they utilize will compete with other fuels on an equal basis, without the use of government subsidies for competing fuels or competing domestic sources of power. Participants in cross-border projects need the freedom to set prices at a level which is competitive with other fuels, as opposed to tying the price of clean fuels to the price of any particular other commodity. However, regulatory authorities need to protect against possible abuse (through gaming or otherwise setting of maximum prices).

5.4.3 Future Financial/Commercial Considerations

Initially, cross-border power transfer was established in the Four Borders Region through government-to-government bilateral treaties and agreements that were not developed on a commercial basis. Presently, trading by cross-border projects is contemplated using standard bulk power purchase agreements and bulk power transmission agreements, negotiated on commercial terms.

Prior to the development of an organized regional trading system, buyers and sellers should be able to work directly with each other to develop creative and efficient commercial structures that satisfy customer needs. For example, the tariff and issues for power imports to India from Nepal for the West Seti Project have involved direct discussions between PTC of India and the private developer, Snowy Mountain Engineering of Australia. This approach was contemplated in the 1997 Power Trade Agreement between India and Nepal (Article 1), which allows power trading among all parties, whether they are in the public or private sectors.

In order to establish a competitive regional power trading network, eventually, a much different form of power contract will be needed. With power marketing and trading, there is a need for a different form of electricity contract that is clear, concise, and more easily modified than traditional PPAs that generally refer to tariff schedules and other provisions adopted by reference and that are often imprecise, inflexible, and asymmetrical/one-sided on liability issues. Also, power transfer and trading agreements need to be standardized, given that transactions are typically treated as identical hedges and change hands through multiple (daisy-chain) re-sales and trades.

Applying standard terms also reduces uncertainties and establishes the reciprocal rights and obligations of each trading partner upon performance/nonperformance. Moreover, clear procedures and specified legal terms allow traders to focus on negotiable terms of price, quantity, duration, and delivery point.

Also, a successful risk management program is needed to support regional power trade and transfer that requires: (i) a Master Agreement providing credit enhancement (in the form of collateral or guarantees); (ii) an internal tracking system to measure, manage, and control trading activity risks; and (iii) risk management policies and tools. The principal contract risks to manage: market (price) risks to cover price volatility in electric markets caused by severe weather conditions during peak demand periods, inadequate credit, price and legal risk controls, and inexperience among market participants; liquidity risks (supply availability) to recognize oral agreements as binding and to clearly define most commonly traded products; credit risks (collateral/guarantees); legal risks (force majeure, default, termination, etc.); and operational risks (delivery ability).

To further illustrate the various agreements that would promote regional power trade in the Four Borders Region, as a related task activity, the SARI program has developed various exemplary agreements that are meant to serve as a starting point for assessing the details of various options for understanding the structures, terms and conditions of regional power trade and transfer. These exemplary agreements are based on the successful experience in selected countries in other regions and include organizational agreements, bulk power purchase agreements and bulk transmission agreements.

5.4.4 Implementation Frameworks for Regional Energy Transfer and Trade

Power sector restructuring by countries throughout the world has been driven by a compelling interest to establish competitive power markets through national reforms. A consequence of such reforms has been a global trend towards promoting regional energy trade. Successfully implement regional power trade, however, depends on extending the legislative and regulatory frameworks that have been developed to meet domestic demand and effectively adapting them so as to provide for cross-border transmission interconnections with rationalized transmission tariffs, open transmission access, compatible grid codes and common market rules that govern buyers and sellers in different countries. Moreover, successful implementation of regional power trade and transfer involves developing agreements that facilitate three levels of international coordination: (i) coordination among national energy policies through a "Government Representative" (usually a Ministry of Power); (ii) coordination among national transmission system operators ("TSOs"); and (iii) coordination among national energy regulators. Such regional coordination and agreements should be based on principles of cooperation and mutual benefit and supported by rules for: (i) protection of grid stability; (ii) definition of access rights to transmission networks, including selection of methods of managing congestion and responsibility for planning and investments in new interconnections; and (iii) network service tariffs (payments among TSOs and payments by transmission system users to TSOs).

Draft MOU Among SARI Member Countries: Regional power trade can be implemented through mechanisms such as a formal trade treaty or, as in the case of the Four Borders Region, power trade can be implemented in phases, with a minimum of requirements outlined in generalized memoranda of understanding or even more loosely drafted "heads of agreement". Consider, for example, the agreements that have governed the one of the two existing examples of cross-border power transfer in the Four Borders Region --- the power exchange between India and Nepal (50 – 150 MW). This cross-border power transfer has been implemented informally through a Power Exchange Committee (Terms of Reference, 1992) and subsequently supported by the Power Trade Agreement (1997, executed by GOI and pending ratification by Nepal).

This report has recommended re-affirming these provisions by not only India and Nepal but also Bangladesh and Bhutan, as part of implementing the recommended Phase I regional interconnection (up to 500 MW). Appendix B1 includes an exemplary MOU that would ratify the agreements between India and Nepal and extend them to include Bangladesh and Nepal (as the "Regional Power Exchange Committee"). By way of comparison, also included as Appendix B2 is an exemplary MOU that is based on the provisions of the Intergovernmental MOU that were used by the twelve countries that established the regional power pool in South Africa (SAPP).

Draft Treaty Among SARI Member Countries: Phase II power trade involving more than 500 MW would benefit from a more formally organized regional organization. To stimulate a discussion of the issues and considerations involved, Appendix C is an exemplary agreement adapted from a recent treaty executed to implement regional power trade in Central America through "Regional Market Agents" that are designated by each participating country in the region.

Additional exemplary agreements for adaptation to SARI countries are also provided in Appendix D, based on the Inter-Utility Agreement MOU and the agreement establishing a regional Coordination Center that were developed by SAPP.

In further support of implementing the Four Borders Project, under a related SARI/Energy task activity, additional exemplary agreements have been prepared and presented, for comparative purposes, with existing agreements providing for bulk power sales and bulk transmission services.

Section 6 Environmental and Social Issues

6.1 SCOPE OF THIS ASSESSMENT

This section of the report presents a preliminary review of environmental and social issues related to the power transmission options discussed in Section 4. Appendix E sets out a more complete discussion of environmental impacts associated with transmission lines.

In preparing this environmental review, a site visit was undertaken to the so-called chicken-neck area of India. Interviews were carried out with staff of the Eastern Region of the Power Grid Corporation of India Ltd.; and existing documentation was reviewed, including PGCIL environmental and social guidelines and preliminary Environmental Assessments of projects undertaken by PGCIL within and outside the chicken-neck area.

Electric power transmission lines are linear facilities that affect natural and socio-cultural resources. The effects of short transmission lines can be localized; however, long transmission lines also can have regional effects. In general, the environmental impacts to natural, social, and cultural resources increase with increasing line length. As linear facilities, the impacts of transmission lines occur primarily within or in the immediate vicinity of the right-of-way. The magnitude and significance of the impacts increase as the voltage of the line increases, requiring larger supporting structures and right-of-ways. Operational impacts also increase. For example, electromagnetic field effects are significantly greater for 1,000 kV lines than for 69 kV lines. As well as these direct impacts, there are a number of cumulative and indirect impacts related to power transmission lines, for example ,the way in which the power is generated.

The PGCIL approach to route selection can be found in Appendix E.

6.2 BASELINE

As the Four Borders Project, and therefore the route selection, is currently at a definitional stage, specific environmental and social impacts resulting from the right of way cannot be identified at this stage. However, the proposed project will involve construction activities between Siliguri in Darjeeling District or West Bengal and Purnea in Purnea District of Bihar. A brief description of the baseline environmental conditions follows.

Topography: The most striking geographical feature of Bihar is the sharp division between the flat northern Ganga floodplain area and southern mountainous region. Elevation ranges from 300 to 1300m OD. Purnea is located in the northern floodplain area. West Bengal is similarly divided between the northern upland area, comprising the districts of Darjeeling, Jalpaiguri and Cooch Bihar, and the lowland Ganga plain with major river tributaries including Damodar, Mayurabashi and Rupnarayan.

Climate: As with the topography there are large variations in climate across the states, a fact that is reflected in the temperature variation of between 4 and 47^{o} C. Northern Bihar is temperate whereas more southern areas are hotter. A similar climate prevails in West Bengal with maximum and minimum temperatures of 41^{o} C and 7^{o} C. The project area is subject to the South Asian monsoon giving distinct wet and dry seasons, rainfall ranging between 100 – 200 cm.

Soil and Mineral Resources: The soils in the lowlands are predominantly alluvial. Bihar is rich in mineral resources, the major ones being coal, iron, mica, copper, manganese, and chromite. The major minerals found in West Bengal are coal, iron ore, copper and limestone.

Ecological Resources: Of the 174,000 km^2 of Bihar, just over 29,000km^2 (16.9%) is covered by forest. Of this area approximately 24,000 km^2 is protected and 5,000 km^2 is reserve forest. In West Bengal just under 12,000km^2 of the total 89,000 km^2 is covered by forest, of which 7000km^2 is reserved, 3700 km^2 protected and 1000 km^2 unclassified

6.3 ENVIRONMENTAL IMPACT ISSUES

A number or environmental impacts are associated with the construction and maintenance of transmission system facilities. Those impacts related to the proposed Four Borders Project are outlined below.

6.3.1 Land Take

Impacts: Electric power transmission lines have both a temporary and a permanent impact on land resources. During construction in normal conditions on agricultural land, a temporary right-of-way is created. In addition there will be a land requirement for construction roads and lay down areas. Permanent land take is required for the footprint of the transmission towers and substations, for example, the substation currently under construction at Siliguri occupies an area of land 450 m by 450 m. Previous projects in the region have shown that permanent land take for a transmission tower ranges between 0.2 and 1m^2, although this project is more likely to utilize large towers and will consequently be at the higher end of the scale. PGCIL's policy is to give preference to Government owned land for this purpose, thereby minimizing disruption to private dwellings or agriculture.

Grazing and other agricultural uses are usually not precluded in rights-of-way, but other uses are generally not compatible.

The narrowness of the chicken-neck area and its significance as a conduit to eastern India means that land take is a potentially significant issue. Population density is high and almost all available land is under agriculture.

Mitigation: One of the key considerations in the project planning stage to reduce land take is to consider corridor sharing as much as possible by placing towers adjacent to existing transmission corridor or along road or rail corridors. Another option is to use existing towers with additional transmission lines, although this might require strengthening of the towers or addition of a structure on top. In general corridor sharing with existing facilities minimizes impacts by:

- Reducing the amount of new right-of-way needed
- Concentrating linear land uses and reducing the number of new corridors
- Creating an incremental, rather than new, impact.

In view of the narrowness of the region the options for the Four Borders interconnection considered in this report were structured so as to circumscribe the chicken-neck area and to use existing facilities as much as possible in order to minimize environmental impacts.

6.3.2 Agriculture

Impacts: The construction and maintenance of high voltage transmission lines across or adjacent to agricultural fields can affect farm operations in numerous ways (see Appendix D).

Problems with potential soil erosion and compaction can be lessened by avoiding construction and maintenance activities during times when the soil is saturated (during the monsoon). If the ground is damaged, then chisel ploughing in the compacted areas should be undertaken.

Agriculture in the project area is dominated by three types – subsistence agriculture (including rice paddy), cash crops (including tea, oranges, cardamom, and jute), and forest (including bamboo). The vast majority of the agricultural activities in the region are undertaken by hand or using oxen, and therefore the impacts of transmission towers as physical barriers to machinery is likely to be minimal.

At present, if construction activity is undertaken on agricultural land during the growing season then compensation for loss of crops is paid by Power Grid Corporation. The majority of the growing season is during the monsoon, which is when groundwater levels are high and dewatering necessary for construction of foundations. Construction under these conditions has potential for more significant impacts, such as increased soil loss and compaction, and is more expensive.

Mitigation: Construction for the Four Borders Project should be undertaken as far as possible outside of the monsoon period and sensitive agricultural areas should be avoided. However, where impacts are unavoidable, compensation for loss of crops during the growing season should be paid in accordance with PGCIL's current policy.

6.3.3 Forests

Impacts: Building a major high voltage power line through a forested area would require clearing of many hectares of trees and shrubs. Depending on where the line is placed, this clearing could cause public (and private) forest devaluation, forest fragmentation, general loss and degradation of woodland habitat, and pulp and timber losses.

The majority of the forested areas are found in the uplands of Darjeeling, Sikkim, Bhutan and Nepal. Any power transmission project within Nepal or Bhutan will almost certainly involve passing through some forested areas. One significant area of forest in the chicken-neck area is found between Baghdogra and Naksalbari. It is currently unaffected by the existing transmission line corridor. In addition a Forest Reserve at Jaldapara is located 110 km from Siliguri. On a smaller scale, strip forested areas typically lining roads or canals may be slightly impacted by the power line right of way, although this will have only a very minor impact on the forest resource.

Mitigation: The transmission lines associated with the Four Borders Project should be carefully routed so as not to disturb existing sensitive forest areas. Where areas of forest are unavoidable, a careful program of clearance and replanting should be undertaken. PGCIL, in partnership with the Forest Department, undertakes replanting programs around permanent facilities such as substations. A similar program should be instituted for the Four Borders project.

Maintenance of the transmission line corridor through forested areas will involve physical clearance, which should be undertaken at a convenient time of year so as not to impact upon local agriculture.

6.3.4 Rivers

Impacts: The type and significance of power line impacts on rivers and streams will vary depending on the characteristics of the water resource. Soil erosion during construction caused by driving vehicles through streams, building temporary bridges, or right-of-way clearing activities can decrease water quality. Clearing overhanging trees and brush can result in increased water temperatures, reducing habitat quality for fish and other aquatic species. Overhead transmission lines across major rivers and streams may pose a collision hazard for waterfowl and other large birds, especially when located in a migratory corridor. Sand may be extracted from the rivers for construction purposes, particularly for leveling and foundations of the substation.

The project area is subject to the south Asian monsoon, which, coupled with the proximity to the Himalayas, gives a distinct seasonality to its rivers. The flat nature of the land away from the mountainous areas means that the rivers are slow moving, wide and meandering. Extended towers might be necessary for rivers to be crossed in a single span.

Mitigation: Impacts on rivers from power line construction could be reduced by using a single span, thus avoiding any construction activities in the river itself. Single spans of up to 600 m can be achieved with additional height on towers. Stringing of transmission lines should be undertaken at times when river traffic is minimal.

An assessment should be made when any sand or gravel is sourced from a river and site-specific mitigation methods implemented.

6.3.5 Topography and Soil

Impacts: The project area is made up of two contrasting topographic types—the Himalayan foothills and the lowland floodplains. The two areas are subject to different temperatures and hydrological regimes and therefore contain contrasting vegetation and soil types. As the power lines are strung above ground and not buried like a pipeline, impacts upon soils are generally minor. However, soil compaction and disturbance during construction can result in localized impacts on the agricultural quality of soil and increased erosion in rainy season. In mountainous areas mass movement (e.g., landslides) can be a problem, although the foundations of transmission towers are designed to withstand common events. There is seismic activity within the project area, although the PGCIL has not reported any incidents of collapsing towers.

Mitigation: Adoption of specific construction techniques and timing of activities (outside of monsoon periods) can significantly reduce soil compaction and erosion. Monitoring of the transmission lines and substation sites for soil erosion, and for damaged equipment, and leaking cooling oils followed by satisfactory maintenance can reduce many potential impacts.

6.3.6 Flora and Fauna

Impacts: Transmission lines and towers can provide a danger for birds; however, major bird migration routes or feeding areas are not known to exist in the immediate area (there is a bird sanctuary near the Raiganj district 120 km southeast of Siliguri). Some small loses of flora

will occur through clearance of the substation footprint and transmission towers; however, as long as the site locations and transmission route is selected carefully, disturbance of valuable, rare and mature species can be avoided. The PGCIL has not experienced problems with birds hitting transmission towers. The largest potential impact is in forested areas (see above), however the PGCIL minimizes any impact by avoiding the use of chemicals. Instead, they physically clear forest areas and canopy within the right-of-way.

Mitigation: An assessment of sensitive and important natural habitats should be undertaken prior to the siting of the substation and transmission lines, and the lines need to be sited to avoid these areas as much as possible. In addition, the use of chemicals to clear rights-of-way should be avoided.

6.3.7 Archaeological and Cultural Resources

Impacts: Although archaeological sites in the project area were not identified, there are religious sites in the area but these are generally avoidable with careful route planning. Some may even be moved away from the construction sites, as is the case at the new substation at Siliguri where a graveyard (burial ground) has been relocated.

Mitigation: The routing survey should identify any archaeological or cultural sites in the proposed transmission corridor. The final route selection should avoid any significant sites.

6.3.8 Aesthetics

Impacts: local residents may view new transmission lines in a positive light in that these facilities represent economic development. This is quite likely to be the viewpoint in many parts of the project region with the population welcoming any potential economic gains, and the staff of PGCIL insist that this is the case. Therefore, people tend to overlook the visual impacts. However, in the mountainous areas of Bhutan and Nepal where tourism is an important industry, visual impacts may be more significant.

Mitigation: In areas where aesthetic impacts may be significant, such as areas of tourism, a visual impact assessment should be undertaken and the transmission line routed to minimize potential impacts.

6.3.9 Health and Safety

Impacts: Placement of low-slung lines or lines near human activity (e.g., highways, buildings) increases the risk for electrocutions. There is also a minor risk from induced currents from nearby ungrounded metal objects, and although these are generally minor, refueling of vehicles should not be undertaken under power lines.

Where corridor sharing is proposed, care should be taken that the sharing is compatible, for example the transmission lines should not interfere with the communication and power linesassociated with railways. In these instances, the rail communication system may need to be placed underground. Similarly, induced current effects can occur when power lines are run in parallel with pipelines, from which corrosion impacts can arise.

For protection against lightning, transmission lines are usually built with a grounded shield wire at the top of the towers or poles. The project area, especially in the mountainous region, is subject to lightening strikes and operations have been affected in the past. In general risks are low with overhead power lines as long as basic precautions are taken.

Mitigation: For the proposed projects, careful route selection should attempt to minimize the numbers of crossing points at highways, railways and pipelines. Where corridor sharing is feasible, the compatibility of the transmission lines within the existing corridor needs to be carefully examined. Appropriate lightning conducting features should be incorporated into transmission tower design.

Where power lines impact upon existing telecommunication lines, mitigation measures include rerouting and burying of the existing lines. The cost of such measures is shared by Powergrid and the Telecom Department and averages out at between Rs 5,000 – 10,000 per km of transmission line.

6.4. SOCIAL IMPACT ISSUES

Social impacts arise when normal life is interrupted either permanently or temporarily by project activities. The key areas of social impact with the Four Borders Project are:

- **Displacement and resettlement**: Careful site selection for the substation and route selection for the power lines means that displacement and resettlement of population are unlikely. PGCIL's policy is to give preference to Government-owned land for this purpose, thereby minimizing disruption to private dwellings or agriculture. An expansion to the existing substation is currently under construction at Siliguri. This expansion has not lead to any displacement or resettlement of population. A preliminary EIA (Oct 1998) for the development of a new substation in Purnea predicted the displacement of approximately 19 families.
- **Land take**: Permanent land requirements include the footprints for the substation and the transmission towers, although a preliminary environmental impact assessment undertaken in nearby Bihar estimated that the permanent land take for the transmission towers would be between 0.2–1 square meter per average farm holding. Temporary land requirements will be more extensive, including lay down areas and construction roads. However, these features will only be present during the construction period. A compensation scheme based on loss of earnings can alleviate the majority of temporary and permanent land take issues.
- **Agriculture:** In addition to loss of land, impacts upon agriculture include compaction and erosion of soil resources. The project environmental management plan should commit to tackling these issues with a clear remediation and restoration plan.
- **Construction related traffic**: During the construction period, there is likely to be an increase in heavy vehicle movements in the locality of the construction sites. As the roads are already congested in the area this increase could have a potentially significant impact on the health and safety of the local population. Road safety in the region is very poor and daily life is to a large extent is centered around the roads. These impacts can be mitigated to a large extent by careful planning and execution of construction activities.

All options analyzed for the Four Borders Project appear to have minimal environmental impacts, largely because they use existing infrastructure to the extent possible.

6.5 PROJECT OPTIONS

The most significant potential environmental impacts are outlined for the following options, detailed in Section 4. In all cases there would appear to be minimal environmental impacts associated with each of these options.

6.5.1 Options A1 and A2

Option A1 consists of construction of a new Four Borders substation at Siliguri; and construction of new 132 kV transmission lines from the Four Borders substation to the Anarmani 132 kV substation in Nepal (50 km) and to the Thakurgaon 132 kV substation in Bangladesh (90 km). Option A2 consists of the same configuration, but with a slightly different transmission route and with the new Four Borders substation located at Purnea.

The majority of the construction activity will take place in the lowland areas of India and Bangladesh and thus land take, which is permanent for substation and temporary for the majority of the transmission lines, will impact the agricultural areas. The part of the transmission line in Nepal may require some forest clearance. It is almost impossible to avoid crossing any rivers while implementing this project, although if a single span crossing is used then impacts will be minimal and limited almost entirely to the construction period. Soil resources may be susceptible to erosion during construction in the uplands, and the soft and flooded soils in the lowlands may require specialized construction techniques.

The following table summarizes the potential environmental and social impacts that are likely to arise from these options. It should be noted that this table, and the subsequent tables in the section, does not list all the activities and environmental resources considered during this environmental evaluation, but only those where a potential impact was deemed to arise.

Table 6-1: Summary Impact Matrix for Options A1 and A2

Activity	Vehicle movements and access	Land clearance	Construction of substation	Operation of substation	Construction of transmission lines	Operation of transmission lines
Environmental Resource						
Land take						
Agriculture						
Forests						
Soil						
Air quality						
River water quality						
Aesthetics						
Cultural and Archaeological Resources						
Displacement of population						
Health and safety of population						

Minimal potential impact
Significant potential impact

6.5.2 Options B1 and B2

Option B1 consists of construction of a new Four Borders substation at Siliguri; construction of a new 132 kV transmission line from the Four Borders substation to the Anarmani 132 kV substation in Nepal (50 km); and construction of a new 220 kV transmission line from the Four Borders substation to the Ishurdi 220 kV substation in Bangladesh (435 km). Option B2 is as above, but with the new Four Borders substation located at Purnea.

The environmental impacts will be as per Option A with additional impacts throughout the lowland areas of Bangladesh as the transmission lines are extended to Ishurdi. Bangladesh is prone to flooding during the monsoon period; therefore, construction should be undertaken to minimize impacts upon the water regime. Land take issues will be important as Bangladesh is densely populated and heavily cultivated. Table 6.2 summarizes the likely environmental impacts of these two options.

Table 6.2: Summary Impact Matrix for Options B1 and B2

Activity	Vehicle movements and access	Land clearance	Construction of substation	Operation of substation	Construction of transmission lines	Operation of transmission lines
Environmental Resource						
Land use						
Agriculture						
Forests						
Soil						
Air quality						
River water quality						
Aesthetics						
Cultural and Archaeological Resources						
Displacement of population						
Health and safety of population						

Minimal potential impact
Significant potential impact

6.5.3 Options C1 and C2

Phase I of Option C1 is essentially like Option A1, and Phase II involves disconnection of previous Four Borders to Thakurgaon 132 kV transmission line from Thakurgaon 132 kV substation and construction of 220 kV transmission line extension from Thakurgaon vicinity to Bakarpuria 220 kV substation (additional 70 km). Phase II also consists of disconnection of previous Four Borders to Anarmani 132 kV transmission line from Anarmani 132 kV substation and construction of 220 kV transmission line extension from Anarmani vicinity to Duhabi 220 kV substation (additional 65 km). Option C2 is as above, but with the new Four Borders substation located at Purnea.

The most significant difference between options C and A is the additional 65 km of transmission lines constructed in Nepal. In the upland areas issues of land instability and soil

erosion are significant. Nepal receives a significant number of tourists each year so aesthetic impacts of transmission towers may be significant, although these are likely to be ameliorated with a sound routing plan. The likely environmental impacts associated with these options are summarized below in Table 6.3.

Table 6.3: Summary Impact Matrix for Options C1 and C2

Activity	Vehicle movements and access	Land clearance	Construction of substation	Operation of substation	Construction of transmission lines	Operation of transmission lines
Environmental Resource						
Land use						
Agriculture						
Forests						
Soil						
Air quality						
River water quality						
Aesthetics						
Cultural and Archaeological Resources						
Displacement of population						
Health and safety of population						

Minimal potential impact
Significant potential impact

6.6 BROADER ISSUES

As well as the more localized impacts described above that result primarily from the construction and operation of the power transmission lines, there are a number of international and *trans-boundary issues* that should not be overlooked. There are significant benefits of a more reliable power supply, improved regional co-ordination and improved relations between the neighboring countries.

The options above present scenarios for projects that cross between Bangladesh, Bhutan, India, and Nepal. Some of the key issues in any trans-boundary project are institutional issues, raising questions such as which organization(s) takes the responsibility of implementing environmental management, in accordance with what laws and regulations, and to what level of detail in each of the different countries? There must be compatibility in the way environmental and social issues are dealt with in a trans-boundary project such as this. For example, routing of the transmission lines should be undertaken with input from all the involved countries with each one expressing its concerns. It may be necessary to harmonize, between the concerned countries, the approach to environmental management adopted on these specific projects. It should be noted that harmonization on a specific project basis requires high-level support, or buy-in, from each country. It does not mean changing the laws of each country, which is unrealistic politically and could not be accomplished within the project timetable. Such a harmonization allows the project developer to complete the

project in a realistic and economic timeframe without compromising environmental and social issues.

There are also a number of *indirect impacts* from this project. The project will facilitate the transmission of power being generated by hydroelectric power plants in the upland areas of Nepal and Bhutan. Eventually it may also carry power generated by gas-fired power plants in Bangladesh, although initially Bangladesh will be an importer of power.

There is likely to be a perceived benefit from power lines passing through the region because, as mentioned in Section 2 above, power lines generally are seen as a sign of development. The majority of the environmental impacts will be felt locally, but is there any real benefit to the local population? Will electricity supply be improved in the chicken-neck area or will it pass this region by?

The primary reason for the proposed options above is to link power supply with demand at a regional and international level, although the project does provide for the construction of a substation in the chicken-neck area that may ultimately be used for local supply. Similarly, the potentially huge environmental and social impacts associated with developing hydroelectric power resources are felt in localized areas, whereas the benefits of the power consumption are felt at some distance, for example pollution abatement of coal-fired power generation in India.

The benefits, particularly in reduction in atmospheric emissions, of utilizing water and gas for generating power in preference to more traditional hydrocarbon fuels are widely documented and on the whole positive. There are of course serious environmental and social consequences arising from development of both gas and hydro power plants. These issues, both positive and negative, which include altering the regime of rivers, displacement of communities, flood control, valley inundation, geo-technical instability, etc., should be thoroughly addressed on a project-by-project basis. Detailed consideration of these issues is beyond the scope of this report. However, these issues are important and need to be addressed within the realm of promoting regional power trade among SARI/Energy countries.

The applicability of the Clean Development Mechanism, arising from the Kyoto Protocol, is unclear despite recent advances at COP 6 in Bonn. Complicating factors include the fact that the HEP projects are located in different countries (Nepal and Bhutan) from where the power will be used (India and Bangladesh), and the HEP projects might be financed by multilateral sources such as the World Bank or Asian Development Bank. In these situations, it is unclear what Certified Emissions Reduction credits will arise and where they will be attributed to.

6.7 NEXT STEPS - ENVIRONMENTAL

Environmental issues need to be incorporated into project decisions. Figure 7-4 below provides a generic outline of how environmental and social issues should be addressed throughout the project cycle.

Individual activities will require emphasis at different times throughout project development. At this pre-feasibility stage of the project, the environmental “showstoppers”, or issues, which are of such significance that they make the project technically or economically unfeasible, should be identified. As the project gains momentum, a scoping study and a full environ-mental impact assessment should be undertaken, involving collection of baseline

data, assessment of impacts, and development of mitigation measures. An additional recommendation for this proposed Four Borders Project is that a summary environmental and social impact assessment be undertaken for the entire planned network of power plants, substations, and transmission lines so that the cumulative and regional impacts are thoroughly recognized and understood. Throughout construction, an Environmental Management Plan should be implemented to translate the commitments made in the environmental impact assessment into practice. Then, throughout operation an Environmental Management System needs to be in operation to monitor, maintain and improve the environmental performance of the facility.

On the basis of this preliminary environmental assessment, it is recommended that, if the proposed Four Borders project proceeds, an environmental assessment team be formed with representatives from each country. This team would address environmental issues associated with the project and would coordinate with the project's Working Committee.

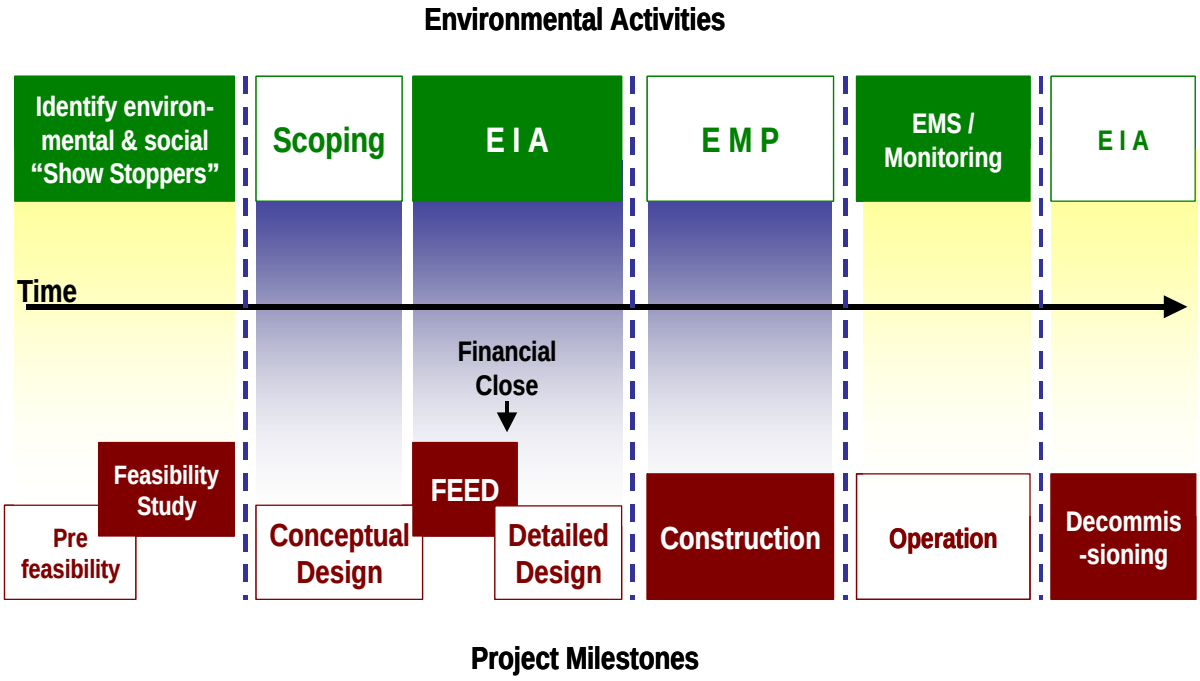


Figure 6-1: Activities throughout the Project Cycle.

Based on this analysis, it is recommended that an Environmental Assessment team be formed with representatives from each of the four countries to review the environmental impacts associated with the Four Borders project and coordinate with the project's Working Group.

Section 7 Conclusions

This pre-feasibility study has identified possible alternatives for interconnecting the transmission systems of Bhutan, Bangladesh, India, and Nepal in the Four Borders Region. The purpose of this analysis is to determine the overall viability, at a preliminary level, of a regional interconnection, which would serve as the basis for more detailed analysis of a specific project. Based on this assessment the following conclusions and recommendations emerge:

7.1 CURRENT AND FUTURE SITUATION

- Presently, only limited bilateral power transfer exists with India from government-subsidized hydro projects in Nepal and Bhutan; no power transfer arrangement involves Bangladesh.
- The transmission systems under development in the Four Borders countries limit the size of the interconnected system to 220 kV.
- Power transfer from surplus power from hydropower plants in Nepal and Bhutan can help reduce power deficits in India and Bangladesh.
  - By 2010, India requires at least 4,500 MW from regional power trade.
  - By 2007, Bangladesh requires 1,340 MW from regional power trade.
  - By 2010, Bhutan will have about 1,300 MW of surplus power available for regional trade.
  - By 2011, Nepal will have 475-550 MW of surplus power available for regional trade.

7.2 PROJECT DEFINITION: ASSESSMENT OF OPTIONS

- Three technically viable options were identified to interconnect the grids of Bangladesh, Bhutan, India, and Nepal in the Four Borders Region. The interconnection would be located in India at either the Siliguri (West Bengal) or Purnea (Bihar) substations. None of these options would use land in the constrained chicken-neck region. These options are:
  - **Option A:** Limited Power Transfer based on a 132 kV system;
  - **Option B:** Moderate Power Transfer with Accelerated Development – based on developing a 220 kV system in advance of the system developments in Nepal and Bangladesh; and
  - **Option C:** Moderate Power Transfer with Phased Development – based on developing a 132 kV system initially, which would be upgraded to a 220 kV system in conjunction with the developments in Bangladesh and Nepal.
- **Option C,** which provides a phased approach to development of the Four Borders Project, is the most attractive option.
- The options would permit the transfer of power from 50 MW up to approximately 500 MW.

- Based on technical and investment requirements it appears that AC synchronization would be more appropriate then DC interconnectors.
- Investment requirements for these options would be minimal, ranging from approximately $9 million to $52 million.
- Estimated levelized transmission costs for the alternatives range from 2.6 cents per kWh for power transfers of 50 MW to 0.2 cents per kWh for transfers of 500 MW.
- All of the options have positive rates of return, which increase significantly with the level of power transfer.
- The options presented herein for a Four Borders Project could be implemented within the 2005-2010 period.
- All of the options have minimal environmental impacts, as they rely extensively on existing facilities.

7.3 LEGAL / REGULATORY AND FINANCIAL AND COMMERCIAL CONSIDERATIONS

- Regional power transfer requires unprecedented coordination based on principles of cooperation and shared benefits involving government representatives and transmission system operators from Bangladesh, Bhutan, India, and Nepal.
- Regional power trade could be implemented by adapting memorandums of understanding and coordination agreements similar to those developed by other regional entities such as the South Africa Power Pool or power trade treaty developed in Central and South America.
- Bangladesh, Bhutan, India, and Nepal should each designate the amount of power required or available for transfer and trade, and designate nodal entities and independent regulators responsible for cross-border power transfer.
- Phase I regional interconnections could be supported by payments-in-kind and constructed within existing budgets or with support from a regional fund established by the World Bank and the Asian Development Bank.
- Phase II regional power trade could be developed by attracting private sector developers and investors to build generation and transmission facilities in joint ventures or as third-party owner-operators.
- Ultimately, regional power trade requires an organized trading system supported by generation and transmission projects developed on a commercial basis and supported by power marketing contracts.

7.4 ENVIRONMENTAL AND SOCIAL ISSUES

- The alternatives identified could be developed with minimum environmental and social impacts as they rely on existing facilities to the maximum extent possible.
- A single environmental agency in Bangladesh, Bhutan, India, and Nepal could be designated to address environmental and social impacts of regional transmission facilities and to participate on an environmental assessment team.

Section 8 Recommendations and Next Steps

This pre-feasibility report demonstrates the technical and economic viability of a proposed regional transmission system interconnection in the Four Borders Region.

The proposed Four Borders Project would provide significant system reliability improvements, increased diversity of supply for interconnected countries, improved security of supply, reduced line losses, shared operating and spinning reserves, and shared emergency power.

While only a limited amount of electric power would be transferred (150-500 MW), the proposed interconnection would serve as an important "ice breaker" that demonstrates—in practice—how regional cooperation in energy can be carried out to serve the mutual benefits of all participating countries.

Over the longer term, the proposed interconnection provides greater promise. A regional interconnected transmission grid could expand its capacity to allow substantial power trade at significantly lower cost and reduced environmental impacts by achieving greater economies of scale and optimal use of untapped clean fuels (hydro and natural gas) that is available in abundance in the region.

8.1 RECOMMENDATIONS

To achieve these benefits and to make the proposed Four Borders Project a reality, an implementation strategy needs to be developed. This strategy should be developed with input from all regional power sector stakeholders and should address policy, technical, financial, commercial and environmental issues associated with the project.

The specific elements of the strategy need to reflect the particular circumstances of the Four Borders Region and of the power sectors of each of the countries involved. It is beyond the scope of this pre-feasibility study, and too early in the process, to determine exactly what form this strategy should take. However, based on the initial assessment presented in this report and a review of similar regional power system integration activities in other regions (as noted in Section 5 and in the various Appendices of this report).

It is recommended that a Working Group be established consisting of regional stakeholders representing India, Bangladesh, Bhutan, and Nepal to review the proposed project, serve as a liaison with energy ministries and other sector stakeholders, and develop and oversee the implementation strategy. Major elements of this strategy could include:

- Develop and execute an Inter-Governmental Memorandum of Understanding, which would establish principles for power trade and transfer among the countries to promote an integrated regional transmission system for the benefit of all parties.
- Develop and execute an Inter-Utility Memorandum of Understanding for regional transmission system operators that establishes the operating principles and rights and obligations of participants and the procedures for ensuring full cost recovery and equitable sharing of benefits;

- Prepare a detailed project report for the World Bank and the Asian Development Bank that meets all of the requirements for developing, financing, and implementing the proposed regional interconnection; and
- Establish an Environmental Assessment Team with representatives from Bangladesh, Bhutan, India and Nepal to address environmental and social issues associated with this project and coordinate with the Working Group.

8.2 NEXT STEPS

To accomplish these purposes, the Working Group also could serve as a regional advisory body to coordinate with the USAID SARI/Energy Project regarding related technical assistance that could be provided to help develop and implement the strategy.

Activities that could be supported under the SARI/Energy Project include:

- Review the regional energy supply/demand balance that is being prepared in support of the proposed interconnected grid; confirm the amount and cost of power available for regional power transfer and trade under Phase I and Phase II of the recommended option.
- Validate the Phase I interconnection option and perform a detailed integrated resource assessment in order to quantify the costs and benefits.
- Identify and select favored options for establishing open transmission access, fair pricing and conditions of service for inclusion in a regional transmission services agreement.
- Review legal and regulatory requirements to support development of the proposed interconnection and provide assistance in reviewing existing laws and regulations and drafting any necessary changes/additions in rules, regulations, and laws.
- Provide assistance to establish a regulatory regime that would support development of the proposed regional interconnection by coordinating existing or proposed independent regulatory entities in each country.
- Support development of an initial environmental impact assessment to collect data, assess impacts, and develop mitigation measures that would be implemented through an environmental management plan.

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Appendix A Interconnected Electric Networks and Competitive Electricity Markets

One of the key elements of infrastructure needed to support economic development is the electric power supply industry: the generating stations and networks that deliver electricity to consumers, and organizations involved in marketing electricity and ensuring the stability of the interconnected power system. In areas where there is no grid, or the grid is unreliable, customers need to obtain electricity from diesel generators or small generators using renewable energy (for example, small hydro stations or windmills). In most countries the least-cost method of delivering electric energy to consumers includes a grid-based system (possibly with several isolated grids) as well as isolated generation. The cost of electricity generation in grid-based systems varies enormously from one location to another, depending on the availability of hydroelectric resources, the cost of fuel, and many other factors. As a result of these cost differences, and as a result of the technical advantages of large grids in maintaining system stability, there is a global trend toward interconnection of power systems of neighboring countries.

At the same time that the transfer capacity of high voltage interconnections is expanding, and thereby making it possible to increase the level of electricity trade among countries, there is a global tendency for countries to create competitive electricity markets at the national level. The generation, transmission, and distribution functions of electric sector companies are being separated, making it possible for generating companies and electricity marketing companies to sell electricity to end users. In the European Union the process of power sector restructuring is guided by legislative reforms at the regional level as well as the national level. Regional electricity markets are beginning to develop in Central America and elsewhere.

In view of these two global trends, the planning, financing, and operation of future interconnections should take into consideration the use of transmission networks to support competitive electricity markets. Moreover, the legal and regulatory framework for the development of competitive electricity markets should support investments in transmission interconnections so that the benefits of international electricity trade become available to market participants. Transmission system operators, government representatives, and energy regulatory authorities can work together to achieve both (1) investment in high voltage interconnections, and (2) a legal and regulatory framework supporting competitive electricity markets.

The purpose of this paper is to summarize these two global trends; to identify the benefits of building and strengthening interconnections among electric networks; and to outline the basic considerations needed to support new investment in interconnections when the participating countries have established a legal and regulatory framework for competitive electricity markets.

A.1 GLOBAL DEVELOPMENT OF INTERCONNECTED NETWORKS

Over the last 50 years there has been a global trend in which power systems have formed regional electricity associations to link countries together. There are three major regional electricity organizations in the developed countries and three such organizations in the developing countries:

- Union for the Coordination of Transmission of Electricity (UCTE, see www.ucte.org) member power companies manage the networks of the continental European electricity market (Spain, Portugal, France, Belgium, Netherlands, Luxembourg, Germany, Austria, Switzerland, Italy). The area of synchronous operation of UCTE has already expanded from Western Europe into several eastern European countries (Poland, Czech Republic, Slovak Republic, Hungary, Slovenia, Croatia) that are not part of the EU electricity market. UCPTE (the predecessor of UCTE) was founded in 1951.
- Nordel (see www.nordel.org) member power systems are located in the four interconnected Nordic countries (Denmark, Sweden, Norway, Finland) and in Iceland, which is isolated.[1] Nordel was founded in 1963.
- Comisión de Integración Energética Regional (CIER, the Regional Electrical Integration Commission, see www.secier.org.uy) member power companies are located in Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, and Venezuela.[2] CIER was founded in 1964.
- North American Electric Reliability Council (NERC, see www.nerc.com) members consist of ten regional councils, each of which has members from different segments of the electric power industry. NERC covers the United States (except Alaska and Hawaii) and Canada (except the Yukon, Northwest Territories, Labrador, and Newfoundland).[3] NERC was founded in 1968.
- Arab Union of Producers, Transporters and Distributors of Electricity (AUPTDE, see www.auptde.org) member power systems are located in Jordan, Bahrain, Tunisia, Algeria, Saudi Arabia, Sudan, Syria, Libya, Egypt, Morocco, Mauritania, Yemen, Iraq, Lebanon, Palestine, Dubai, Qatar.[4] AUPTDE was founded in December 1987.
- Southern African Power Pool (SAPP, see www.sapp.co.zw) member power systems are located in Botswana, Mozambique, Malawi, Angola, South Africa, Lesotho, Namibia, Democratic Republic of Congo, Swaziland, Tanzania, Zambia, and Zimbabwe. SAPP was founded in 1995.

[1] Although Iceland has an isolated network, it is represented in Nordel by the power company Landsvirkjum and the city of Reykjavik. The Nordel interconnected region has electricity trade with Germany (via Denmark), Poland (via Sweden), and Russia (via Finland).

[2] Each country is represented by a National Committee consisting of power companies and non-profit organizations. The ten National Committees have approximately equal representation (a maximum of three delegates) on the Central Committee, which is the highest authority of CIER.

3 The members of these Regional Councils come from all segments of the electric industry: investor-owned utilities; federal power agencies; rural electric cooperatives; state, municipal and provincial utilities; independent power producers; and power marketers. These entities account for virtually all the electricity supplied in the United States Canada, and a portion of Baja California Norte, Mexico.

[4] Although Morocco, Algeria, and Tunisia have electricity networks that are synchronously connected to UCTE via Spain, these three North African countries are members of AUPTDE and are not members of UCTE.

The exchange of information on interconnections and other aspects of high voltage network design and operation is promoted by CIGRE (the International Conference on Large High Voltage Electric Systems, see www.cigre.org). CIGRE is headquartered in Paris and is represented in 52 countries (see Attachment 2).

Other organizations promote or operate electricity interconnections in specific regions. For example, in 1985 the member countries of the Gulf Cooperation Council (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates) formed the GCC Regional Committee for Large High Voltage Electric Systems (see www.gcc-cigre.org). Since 1975 the electricity networks of the Central Asian countries (Kazakhstan, Kyrgyz Republic, Turkmenistan, Uzbekistan, Tajikistan) have been dispatched by the Dispatch Center Energija, which became an international organization in 1991 as a result of the breakup of the Soviet Union. On October 11, 1992 the power companies of Poland, Czechoslovakia, and Hungary formed Centrel (see www.centrel.org), which has operated in parallel with UCTE on a permanent basis since April 16, 1998. In December 1996 the presidents of six countries of Central America (Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama) signed a Central American Electricity Market Treaty.[5] In September 1998 one of the Study Committees of CIGRE formed a South East Asia Task Force (Indonesia, Laos PDR, Philippines, Singapore, Thailand, Vietnam, Malaysia).[6] On September 10, 1999 government representatives from six countries in South Eastern Europe (Albania, Bosnia-Herzegovina, Bulgaria, Greece, Romania, and Former Yugoslav Republic of Macedonia) signed a declaration of intent to create a regional electricity market.[7]

A.2 GLOBAL DEVELOPMENT OF COMPETITIVE ELECTRICITY MARKETS

Compared with the development of interconnections, the creation of competitive electricity markets is a recent phenomenon. It began in the late 1980s at the national level in the United Kingdom, Norway, Argentina, and Chile and has spread throughout Western Europe, South America, North America, Australia, and New Zealand. Countries that are being considered for accession to the European Union will need to restructure their power sectors to prepare for EU membership. Many other countries, such as China and India, are permitting competitive electricity markets to develop.

There are several ways in which competition can be introduced into the electric sector:

1. **Tenders for IPPs**. A vertically integrated power company may conduct a tender to solicit proposals from Independent Power Plant developers. The winner of the tender is invited to negotiate a long-term power purchase agreement to sell energy and capacity to the vertically integrated company. This form of competition is effective only when the vertically integrated power company is expected to exist during the whole period of the contract (typically at least 12 years).[8] Similarly, a distribution company may conduct a

[5] Source: James Barker, Jr., Bernard Tenenbaum, and Fiona Woolf, *Governance and Regulation of Power Pools and System Operators: An International Comparison*, World Bank Technical Paper No. 382 (Washington, DC: World Bank, 1997), page 68.

[6] Source: 1999 Progress Report of Study Committee 37, page 4. www.cigre-sc37.org/report99.html

[7] *Declaration of Intent for the Establishment of a Competitive Regional Electricity Market in Southeast Europe*, signed September 10, 1999 in Thessaloniki, Greece.

[8] When a vertically integrated company is broken up into transmission, generation and distribution companies it is possible for an IPP contract to be assigned to a large distribution company, but if the distribution company has access to other supplies at lower prices, there will be a dispute over the price level.

tender for small power generating facilities that will be connected directly to the distribution network.

2. **Competition among vertically integrated power companies**. A company that wishes to import electric energy (or capacity and energy) from other vertically integrated power companies may solicit proposals and select the winning bidder. This situation arises, for example, when a country wishes to import electric energy from neighbor countries and is able to receive competing bids. This is such a "primitive" form of competition that it is not considered an alternative to power sector restructuring.
3. **Wholesale competition**. When generation, transmission, and distribution are unbundled (in management terms, if not ownership terms) the generating companies will compete to supply electric energy to distribution companies (or public electricity suppliers[9]) and large industrial customers. If there is small number of large industrial customers and a very large number of captive customers the market model can be defined as "wholesale competition." Typically the legal framework permits independent electricity suppliers to sell energy to large customers.
4. **Retail competition**. After wholesale competition has been implemented, a country may decide to open up the market to thousands or even millions of customers. This is the long-term policy objective of the European Union, for example. There is no precise definition of the borderline between "wholesale" and "retail" but we consider any market with more than 1000 customers as an example of retail competition. Full market opening is a form of retail competition in which there are no captive customers.

The global trend of the last 12 years has been an increase in wholesale competition and retail competition. When we refer to "competitive electricity markets" we mean wholesale and retail competition. In developing countries the only practical approach to retail competition is to simplify the task of metering and billing by allowing small customers to purchase electricity supplies according a standard "profile" of consumption, and pay for balancing services on a monthly basis according to the difference between metered energy and contracted supply during the month. In other words a developing country should consider the Argentine model of retail competition and not the British model.

When a market has many buyers and sellers it is possible to establish a power transfer that is, an organization that operates a spot market for electricity or operates a trading system designed to facilitate transactions among many buyers and many sellers. The Association of Power Exchanges (APEx) was formed "to facilitate the development and communication of ideas and practices in the operation of global competitive electricity markets" (see www.theapex.org). Its members include power exchange operators and transmission system operators from Australia, Canada, Germany, Ireland, Netherlands, New Zealand, Norway, Spain, United Kingdom, United States, and the developing countries listed below.[10]

[9] In a distribution company, separation of the "wires business" from the "supply business" in management terms (or ownership and management terms) means that there is a need to create a public electricity supplier. Arguably this step is unnecessary when the ultimate goal of restructuring is wholesale competition.

[10] APEx has four membership categories: "A. a party who operates an electricity trading pool; B. a party who engages in an electricity power exchange; C. a party who operates an exchange for trading financial instruments related to electricity trading; or D. a party who operates an electricity transmission system in a competitive electricity market." In fact the members are exchange operators and TSOs.

Power Exchanges in Developing Countries

Country	Power exchange	Web site
Argentina	CAMMESA	www.cammesa.com.ar
Brazil	ASMAE	www.asmae.com.br
Colombia	ISA	Www.isa.com.co/internacional/isa.htm
El Salvador	Unidad de Transacciones, S.A. de C.V.	www.ut.com.sv
Guatemala	Administrada del Mercado Mayorista	
Poland	Polish Power Exchange	Www.polpx.pl/index_e.htm

Source: Association of Power Exchanges publishes a Member List at www.theapex.org/members.html

As the table shows, Latin American countries are well ahead of Asia and Africa in establishing power exchanges. Among the eastern European countries invited for EU accession talks, Poland was the first to open a power exchange. A power exchange has been proposed for Kazakhstan. When Ukraine opened an exchange in 1997 it did not operate successfully, due non-payment problems in the electric sector.

The European Union is the only region of the world in which there is an international treaty supporting the legal and regulatory framework for a "single market for electricity" spanning several countries, and the market is being implemented. Practically speaking Norway and Switzerland participate in the EU electricity market without being EU member countries. As more and more countries in the rest of the world restructure their power sectors to create competitive electricity markets at the national level, there will be opportunities for other groups of countries to establish regional markets, and not simply interconnected networks. For example, on the basis of the Central American Electricity Market Treaty it may be possible to expand the geographic scope of transactions cleared in the power exchanges of El Salvador and Guatemala, and harmonize transmission tariffs and network access rules for the whole Central American region.

Experience has shown that competitive electricity market is much easier to develop when an independent energy regulatory body is created. An independent regulator is needed to establish tariffs for the use of transmission and distribution networks, protect market participants against discrimination, identify obstacles to competition, and propose "next steps" needed to promote the development of the market. Exceptions are possible; for example, Germany is one of the few countries in the world where the electricity market is competitive despite the fact that the Regulator exists only at the regional level (in the European Commission) and not at the national level.

In countries with many generating stations, competition among generators is possible at the national level. This is normally the situation in larger countries. In countries with a small number of generating stations, or a small number of generating companies with hydroelectric resources, competition among generators and imports is possible only at the regional level. In either case market reforms must begin at the national level before the benefits of electricity trade can be fully realized. Unless domestic electricity markets are opened under a sound regulatory arrangement, the expansion of trade will be limited.

A.3 POTENTIAL BENEFITS OF INTERCONNECTIONS

There are four possible reasons to support interconnections among the electric networks in a region consisting of a group of countries:

1. **Generation cost savings**. Over a region composed of a group of countries, the development of electricity trade enables each country to meet hourly electric load and customers' annual requirements using a least-cost mix of generating sources. Because generating resources are varied, including hydroelectric resources, electricity trade usually enables power systems to lower their generation costs over any 12-month period. The cost savings should be reflected in lower prices to the consumer or greater capital expenditure on measures needed to reduce losses, reduce theft, and improve system reliability. In either case the customer should receive a benefit. Because the cost of electricity from a new generating unit is related to its location, a regional market allows generators to choose from a wider variety of sites to find the one that is expected to minimize generation and transmission costs. The potential for generation cost savings is particularly important for smaller countries and for countries that are heavily dependent on a single fuel or type of power generation.
2. **System reliability improvements**. Interconnections among high-voltage networks of neighboring power systems make it easier to stabilize frequency and voltage and reduce the cost of instantaneous reserves and spinning reserves for the power systems that are joined together. The net effect of interconnection could be an increase in the reliability of electricity supply, or a reduction in the cost of electricity to the consumer, or some combination of the two.
3. **Competition benefits and power sector reform**. It is easier to create a competitive electricity market in a group of interconnected countries than in a single country, unless it is a large country with a highly interconnected grid. The larger the number of generating stations and producers connected to the grid, the greater the chances that the consumer will benefit from a competitive electricity market. This consideration is particularly important for countries in which generating resources are controlled by a company with monopoly power. Power sector reform in small countries is more effective when a regional market is established for an unbundled power sector, because regional markets facilitate competition.
4. **Macroeconomic benefits**. Generation cost savings enable suppliers to provide electricity at lower prices to the customer. Reliability improvements either reduce the economic cost of power outages or bring cost savings that can be passed on to the consumer. Competitive markets provide the incentive to improve efficiency and provide the consumer with the best combination of price and quality. When electricity trade results in lower prices, the economic development of the region is promoted. The countries that have a comparative advantage in electricity generation – for example, countries with surplus hydroelectric power or high-quality coal reserves – will export electricity to countries that have a comparative advantage in other types of economic activity. International trade is normally beneficial to economic development when import and export prices are not artificially manipulated by governments.
5. Ideally generating cost savings should be measured on the basis of the total social cost of power generation, that is, the sum of costs paid by the generator (and normally reflected in the sales price of electricity) and the cost associated with externalities that are "paid" by the society as a whole (and possibly omitted from the sales price of electricity). If the countries in a region have established legal and regulatory frameworks that discourage

environmentally harmful forms of power generation and encourage environmentally friendly forms of power generation, network interconnections could make it easier to achieve the optimal mix of generating sources. On the other hand, if generators do not face the "right" incentives, network interconnections could make the situation worse, by expanding the market area in which environmentally harmful forms of power generation can compete with other sources. The possibilities created by network interconnections merely underscore the need to establish responsible environmental management systems.

It is useful to distinguish two possible conditions of electricity trade among interconnected power systems:

1. **Import, export, and transit among a group of countries.** This kind of trading arrangement will enable the countries to maximize the benefits from electricity trade. In this situation it is possible for a country to import electricity from a country that is not a neighboring country. When a large geographic area is involved, the number of possible import and export transactions is very large; this is the most favorable condition for a competitive electricity market to develop. To facilitate energy flows over a large number of possible physical paths it is necessary to have one large synchronous interconnected system. A small number of physical paths can be implemented by asynchronous interconnections. In some regions both synchronous and asynchronous interconnections are needed to create a single market for electricity.
2. **Export-import trade between neighboring countries**. This kind of trading arrangement will permit the countries to obtain only limited benefits from electricity trade. These transactions can be implemented with either AC or DC interconnections. Asynchronous (DC) interconnections are used where it would be very difficult to achieve a high degree of coordination or to implement uniform standards for network construction and operation. When a country imports electricity from its neighbor, in some cases the electronic energy flows over a short physical path (for example, 100 km). Perhaps the simplest example of import-export trade between neighbor countries is the connection of a small "island" to a large neighbor country.[11]

In special situations it is possible to have a synchronous interconnection with no electricity trade.

A.4 GENERATING COST DIFFERENCES AFFECTING THE NEED FOR INTERCONNECTIONS

To develop interconnections that will support competitive electricity markets, or to develop competitive markets that will support interconnections, it is necessary to understand the economic forces supporting electricity trade among countries. From a legal standpoint it may be possible to create a "single electricity market" over a large region such as the European Union but transactions between producers (or suppliers) and end users will not cross national boundaries unless there is an economic rationale for cross-border trade. In this respect it is useful to compare the cost of power generation and transmission in different countries, and estimate the cost of interconnections, regardless of the ownership of the assets and the

[11] For example, Uralsk and Aktyubinsk are located in Kazakhstan but connected to the Russian power system because they are far from the main interconnected power network of Kazakhstan. In 1999 the unified power system of Russia operated in an island mode with the power systems of Kazakhstan, Finland, Norway, China, and Mongolia. http://www.cdo.org

identities of buyers and sellers. Electricity trade will tend to develop when the following conditions are met:

1. **At least one country in the region has existing generating capacity that can produce electric energy for export at relatively low cost.** Common examples of exporting countries are those with vast, low-cost hydroelectric resources; those with large hydroelectric generating capacity but very limited reservoir capacity, who need to export surplus run-of-river hydro when the reservoirs are full; and those with large nuclear generating capacity who need to export nuclear generation during off-peak periods (for example, at night during the season that is not a peak season).
2. **At least one country in the region can build new generating capacity that can produce low-cost electric energy for export**. A common example is a region in which a few countries have large undeveloped hydroelectric resources while the other countries have very limited opportunities for further development of their hydroelectric resources. Another example is a region in which one country has very large natural gas resources but limited opportunities to export gas; this country may be able to export gas-fired electricity generation.
3. **During many hours of the year, the countries in the region have different levels of short-run marginal cost of electricity generation**. For example there could be a region in which base load capacity is concentrated in one country, peaking capacity is in another country, and intermediate capacity is in a third country. Together these three countries may have a reasonable mix of generating resources available to meet the load duration curve of the region as a whole, but each country individually has the "wrong" mix of generating resources.
4. **A significant portion of each country's electricity consumption is located in urban areas or large industrial plants that are most efficiently served by electricity networks**. The opportunities for isolated power generation (diesel generators and small-scale renewable resource generation) are limited to rural areas and remote locations that do not represent a large share of national electricity demand.

The first two conditions can be the "driving force" behind construction of new interconnections. The third condition – the diversity of incremental generation costs – may or may not be sufficient to justify investment in an interconnection. The fourth condition is necessary but not sufficient to justify investments in interconnections.

A.5 REGIONAL DIFFERENCES IN THE COST OF GENERATING AND TRANSMITTING ELECTRICITY

The simplest economic rationale for building a high voltage interconnection between two neighboring countries is to enable Country A to export low-cost electric energy to Country B, which is unable to deliver electricity to major cities at a cost that is cheaper than imports from A. If the two countries are small and are not separated by high mountains or other obstacles to the construction of transmission lines, the cost of transmission should not exceed 0.5 US cents/kWh. In this case the rationale for the interconnection is simply that Country A can generate electricity more cheaply than Country B. Typically Country A has the resources needed to export low-cost hydroelectric generation but B does not.

Differences in the cost of generating and transmitting electricity to large industrial customers served by power companies in South America are indicated by a comparison among prices to a "standard" large industrial customer, as shown in the following table.

Electricity prices to large industrial customers in South America, 2000

Country	Power company	Price to a "standard" large industrial customer, US cents/kWh
Paraguay	ANDE	2.0
Ecuador	EERSA	2.3
Ecuador	EMELSAD	2.3
Chile	CONAFE	2.4
Ecuador	ELEPCOSA	2.5
Argentina	EDEMSA	2.8
Ecuador	EEASA	3.0
Uruguay	UTE	3.0
Brazil	CEMIG	3.1
Chile	CGE	3.3
Colombia	EEPPM	3.3
Argentina	EDEERSA	3.4
Argentina	EDENOR	3.4
Argentina	EPEC	3.4
Brazil	COSERN	3.5
	ELFEC	3.6
Argentina	EDET	3.8
Peru	SEAL	4.0
Brazil	CELPE	4.2
Peru	EDELNOR	4.3
Peru	LUZ DEL SUR	4.4
Venezuela	CADAFE	4.4
Peru	ELC	4.5
Venezuela	ELEVAL	4.5
Argentina	EDESUR	4.8
Bolivia	CRE	5.0
Peru	ELSM	5.0
Bolivia	CESSA	5.6
Colombia	EPSA	6.7
Argentina	EMSA	7.8
Colombia	ESSA	9.6

Source: CIER at http://www.secier.org.uy/datos/1999/cuad1.htm. Prices exclude taxes and are calculated for an industrial customer with a maximum load of 10 MWe and monthly energy consumption of 5 million kWh.

Differences in electricity generation costs among countries in the Southern African Power Pool are very roughly indicated by the differences in average prices to consumers, as shown in the following table. These figures are not as precise as the data for South America (above) because average prices could be distorted by government subsidies, taxes, and different proportions of household, commercial, and industrial customers.

Average electricity prices in Southern Africa, 1999

Country	Average electricity price, 1999 U.S. cents/kWh
Angola	No data
Zaire	No data
Zimbabwe	3.2
Namibia	3.7
Zambia	4.1
South Africa	5.3
Malawi	5.37
Botswana	6.2
Lesotho	7.5
Swaziland	8.1
Mozambique	9.4
Tanzania	11.0

Source: Data compiled by the Southern African Power Pool Coordination Center (www.sapp.co.zw) from the Southern African Power Pool 1999 Report.

Electricity price data from these two regions (South America and Southern Africa) suggest that differences in the combined cost of generation and transmission are still large and therefore the global trend toward interconnections is likely to continue.

A.6 SYSTEM RELIABILITY FACTORS AFFECTING THE NEED FOR INTERCONNECTIONS

In small isolated electricity networks it is difficult to cope with generation system failures (unscheduled outages at generating units) or transmission system failures (usually, damage to transmission lines caused by storms or accidents) and therefore it is difficult to maintain a high level of reliability. The solution is to connect to a larger network that already exists, or to form a large network through interconnection of many smaller networks. These interconnections reduce the cost of generating capacity reserves, including spinning reserve (or "hot" reserve) as well as installed generating capacity (or "cold" reserve). When a small system joins a large system, the smaller system is almost always the one that benefits. In some instances the addition of the smaller system is justified on the basis of political cooperation or is considered a form of economic development assistance provided by the countries in the larger interconnected system. Otherwise, the smaller system could be asked to pay a major share of the interconnection costs because it will receive a major share of the benefits.

An interconnection between two countries may reduce the cost to both countries of achieving a target level of generation and transmission system reliability. The stability of a transmission system depends not only on its size, but on the number of multiple paths over which electricity can flow from generating units to end users under a variety of accident (system fault) scenarios. A ring-based network is always more stable, for example, than a radial network, because a break at any point along the ring will not prevent electricity from flowing in the remaining portion of the ring. The ability of electric energy to flow over alternative paths from generating stations to major load centers (cities or large industrial

consumers) depends on the location of the generators, the location of the loads, and the capacity of the transmission lines. A very large generating station, or a very large city, must be connected to the grid by two or more high-voltage transmission lines.[12]

In any interconnected system it is desirable to maintain a stable level of frequency and voltage in the transmission system (roughly speaking, voltages of 110 kV and higher) by constantly maintaining a balance between total power generation in MW and total load in MW. This is easier to accomplish when a country has access to hydroelectric stations or thermal power stations that can rapidly adjust power output in response to dispatch instructions. Interconnections may provide access to such generating resources over a large geographic area. For example, the hydroelectric stations on the Volga River are used to control frequency over a large area of Russia that is interconnected by high voltage lines.

If a large country or a large power system cannot maintain stable frequency and voltage, none of its neighbors will want to be interconnected with it. For example, Ukraine has difficulty maintaining stable frequency and voltage in its high-voltage network, and therefore Poland and Hungary have disconnected their power grids from Ukraine despite the fact that the high voltage networks were designed to support east-west power flows. If a large country normally maintains frequency and voltage within an acceptable range but is unable to provide a reasonable guarantee of stability, neighbor countries will reserve the right to disconnect instantly, using automatic control equipment. For example, the agreement among the power systems of Russian and the three Baltic countries (Estonia, Latvia, and Lithuania) allows the Baltics to disconnect from Russia in an emergency when frequency falls suddenly in Russia or becomes very unstable.[13]

A.7 COMPETITION BENEFITS AFFECTING THE NEED FOR INTERCONNECTIONS

In small countries the creation of a competitive national electricity market will be difficult when most of the thermal generation is provided by a small number of generating stations and most of the national hydroelectric generation is provided by one or two rivers.[14] If the country has only a few major cities there may be a small number of commercially viable distribution companies. If the wholesale market will not have many buyers and many sellers at the national level, a useful measure is to join a market formed by several countries, or possibly to join the electricity market of a neighboring country that is large enough to have many buyers and many sellers.

Problems associated with a lack of interconnection capacity among countries, or an absence of procedures to make this capacity available to the competitive electricity market, have been noted by the European Commission:

[12] For an example of reliability criteria see *Summary of the current operating principles of the UCPTE*, at www.ucte.org/Publikationen/English/Main_Uebersicht_E.htm (click on "UCTE-Principles of Network Operation").

[13] Under normal conditions the benefits of interconnection outweigh the disadvantages associated with the risk of unstable operation. There were no problems at midnight on December 31, 1999 despite Y2K fears.

[14] A cascade of hydro stations cannot be divided into competing companies because the upstream reservoirs control the amount of water flow available to the downstream reservoirs. Revenues are maximized when all of the reservoirs on the river are operated in a coordinated dispatch schedule.

In countries whose electricity market is dominated by one or two generators that produce all the electricity consumed in a country, a competitive environment, that is true market competition, can only be realized if a high level of imports is possible.

Furthermore, if cross border trade remains limited and markets are principally national, it is probable that generation capacity in the [European] Union will not be efficiently utilized. For example, if physical constraints on exports remain, it is possible that new generation installations will be constructed in one country despite the existence of spare capacity in another that risks closure…

In order to address these issues, it is essential that the possibilities for trade be maximized. In this context, three major actions are necessary:

- Appropriate rules with respect to the pricing of cross-border trade;
- Rules for allocation and management of scarce interconnection capacity; and
- Where economically justified, the increase of existing physical interconnection capacity.[15]

The European Commission recently prepared a draft Directive and a draft Regulation to address these issues, but the proposals have not yet been approved by the European Council and European Parliament.

A.8 ALTERNATIVE MODELS OF TRANSMISSION SYSTEM OWNERSHIP AND OPERATION

There are three basic approaches to the problem of attracting new investment needed to build new interconnections and remove capacity bottlenecks in transmission networks. The ownership structure of the transmission sector can take one of the following forms:

- **Monopoly of transmission system planning and ownership**. The national transmission company may be given a long-term monopoly on the ownership of all existing and future transmission networks, so that no other company is permitted to construct interconnections or improvements to the high voltage network. This is a reasonable solution when the transmission company is financially healthy and able to invest in the improvements needed to prevent or eliminate congestion. The monopoly rights of the transmission company may be stated as a license condition, for example. However, the transmission company must also be given an obligation to construct transmission capacity to meet the needs of the electricity market, even if that new capacity will adversely affect a generating company or distribution network affiliated with the transmission company.
- **Monopoly of transmission system planning with multiple ownership of facilities.** The existing transmission company may be given ownership of the existing transmission network and the right to be a TSO, as well as the right to conduct transmission system planning for the entire country, but the transmission company and other qualified companies and consortia may be given an opportunity to construct interconnections and improvements to the horizontal network. This is a reasonable approach when a regional

[15] European Commission, *Communication from the Commission to the Council and the European Parliament: Completing the internal energy market*, March 13, 2001. This document is available at http://www.europa.eu.int/comm/energy/en/internal-market/int-market.html .

market is being created but the national transmission companies are unable to finance the necessary interconnections or are unable to make the investments needed to prevent or eliminate congestion after the regional market will be opened. In Europe it is normal to allow new consortia to own and construct undersea cables linking countries. The same principle could be applied to interconnections on land. Any company that hopes to make a profit by removing a transmission capacity bottleneck will be invited to submit a license application. The result is that a country will have two or more transmission companies, but only one TSO.

- **Competitive approach to transmission system planning and ownership**. The existing transmission company may be given ownership of the existing transmission network, but other qualified companies and consortia may be given an opportunity to develop their own transmission system plans and to construct interconnections and improvements to the horizontal network. If the national grid functions as a single grid from a technical standpoint, there is no reason to create two or more TSOs. On the other hand, if the national grid actually consists of two horizontal networks with asynchronous operation or with limited transfer capacity between them (as in Denmark, for example), it is possible to establish two TSOs.

At the national level, the choice between these three options depends in part on the way citizens and customers regard the existing transmission company. If the company has failed to complete interconnections that were promised years ago, or if it has provided unreliable service, it has not "earned" the right to be a monopoly. The issue of attracting investment in the transmission network is not only a national issue, however. Because there will be a need to harmonize the framework for the regional electricity market, it may be a good idea to try to make a regional choice among these three alternatives.

Until competitive markets were introduced, the traditional approach to financing interconnections was to establish long-term contracts for the sale of electric capacity and energy in which the buyer and the seller were both vertically integrated power companies. The traditional approach to planning a large interconnection was to develop least-cost plans based on a forecast period of at least 20 years and based on the assumption that generating stations on both sides of the interconnection would be centrally dispatched on the basis of incremental operating cost. The discounted net present value of revenue requirements (i.e. capital and operating costs) under the two scenarios ("with" and "without" the proposed interconnection) could be compared. The key design parameters regarding the interconnection could be selected so that the interconnection reduces the NPV of revenue requirements under any plausible scenario. These methods of financing and planning interconnections are not suited to a competitive market environment.

The rules for investments in new interconnection capacity must address four questions:[16]

- **Planning.** Who should plan the new interconnections or the improvements to the horizontal network that are needed to support electricity trade? Who is responsible for transmission system planning when international trade is involved?

[16] Similar questions arise when new generating facilities are needed to provide ancillary services for the benefit of two or more countries.

- **Approval.** What government agencies or institutions should approve plans for new interconnections or improvements to the horizontal network? Who should issue a license or permit to build new lines, cables, and substations?
- **Investment.** Who will be the owner(s) of the new interconnections or improvements to the horizontal network? Who is responsible for arranging sources of financing, managing the construction project, and owning the new assets?
- **Operation.** Who will be responsible for day-to-day operation and maintenance of the new interconnection? Although dispatch is the responsibility of the TSO, maintenance could be the responsibility of the owner of the interconnection (when an undersea cable or non-synchronous connection is involved, for example).

Tariff setting is the responsibility of energy regulatory authorities. If the regulators are excluded from the planning and approval process, electricity customers will have a legitimate concern that they should not support tariff increases needed to pay for transmission investments that were never approved by the regulators. From the investor's point of view, therefore, it make sense to include regulatory agencies in the planning and approval process and not simply in the tariff approval process.

A.9 CONDITIONS NEEDED TO SUPPORT INVESTMENT IN INTERCONNECTIONS

To create a favorable environment for investment in transmission interconnections it is necessary for the participating countries to establish:

1. A clear legal and regulatory framework for the development of a competitive electricity market at the national level, in each country

2. A clear legal and regulatory framework for the use of the interconnection by generators, suppliers and other market players

3. A favorable outlook for stable and peaceful political relations among the participating countries

4. The resolution of non-payment problems in the power sector, so that the companies participating the electricity market are able to conduct business without a serious risk of non-payment

5. Elimination of barter transactions in electricity trade among the participating countries

Among these conditions the major challenge for most developing countries is probably the first requirement, a clear legal and regulatory framework for a competitive electricity market. An independent energy regulatory authority should be established, and the transmission company (or companies) should be completely separated in management and accounting terms from the various generation and distribution companies. After power sector reforms have been implemented at the national level, it will be possible to develop the framework for regional electricity trade and thereby establish a basis for investment in interconnections needed to support the regional electricity market.

Appendix B Exemplary Memoranda of Understanding for Regional Power Exchange

There has been a decade of cooperation between India and Nepal involving cross-border power transfer and trade. This cooperation was established through the Power Exchange Committee, created in 1992, and carried out under the Power Trade Agreement (executed in 1997, pending ratification by Nepal). One approach (**Appendix B.1**) to consider is to implement the regional interconnections recommended in the Four Borders Report by amending the existing agreements between Nepal and India to include power transfer and trade with Bhutan and Bangladesh. The following is a re-draft of the 1997 Power Trade Agreement that incorporates the terms of reference of the Power Exchange Committee for carrying out regional power trading activities. As a further example of how regional power trade has been established through a memorandum of understanding, **Appendix B.2** includes, as a second exemplary agreement, a draft MOU, based on the Inter-Governmental MOU executed by the twelve countries that established the South Africa Power Exchange.

B.1 MEMORANDUM OF UNDERSTANDING CONCERNING REGIONAL ELECTRIC POWER TRADE

WHEREAS, His Majesty's Government of Nepal (hereinafter "HMGN"), the Government of India ("GOI"), the Government of Bhutan ("Bhutan") and the Government of the People's Republic of Bangladesh ("GOB") desire to further promote and strengthen the friendly relations existing among them;

WHEREAS, each country has adopted policies of economic liberalization with the intention to promote participation of the private sector in the development of their respective countries;

WHEREAS, each country has emphasized quicker and enhanced development of the power sector through participation of local and foreign private investors in the power industry of their respective countries;

WHEREAS, each country envisage the development of a number of power projects within the foreseeable future in their respective countries; and

WHEREAS, each country, in view of the upcoming power projects in their respective countries have held mutual discussions and have reached an understanding that this Agreement shall facilitate the process of electric power trade among the countries in the region.

NOW, THEREFORE, THE PARTIES HAVE AGREED AS FOLLOWS:

ARTICLE 1

Any party, in Nepal, India, Bhutan or Bangladesh, may enter into an agreement for power trade in the region irrespective of such parties being Governmental, semi-Governmental or private enterprise.

ARTICLE 2

The parties entering into such an agreement for power trade may determine the terms and conditions of such an agreement, including the quantum and parameters of supply, the points of delivery and the price of supply of electrical power to be traded among them.

Such determinations shall be made with the support of a Regional Power Exchange Committee having the following terms of reference: (i) examine adequacy of existing transmission links between countries and propose additional regional links; (ii) examine means of implementing and funding of additional regional transmission links; (iii) monitor progress of regional transmission links under construction and relate to proposed additional regional links; (iv) examine existing tariffs in relation to the actual cost of generation and transmission; (v) recommend principles applicable to regional power trade and transfer that promote an integrated and optimal operations of the different transmission systems for long term power, temporary power supply, seasonal power supply, emergency power supply and restricted power supply (peak and non-peak).

ARTICLE 3

The parties entering into such an agreement for power trade shall be afforded all necessary assistance by respective Governments, in accordance with the laws and regulations of respective countries, for conduct of surveys including field investigations and for the construction, installation, operation and maintenance of facilities required for generation and transmission of power in the territories of the countries, required for such power trading.

ARTICLE 4

The parties entering into such an agreement for power trade shall be granted all of the incentives and concessions by respective Governments available under relevant laws and regulations of respective countries, for generation and transmission of power.

ARTICLE 5

The parties entering into all such an agreement for power trade shall fulfill all necessary requirements stipulated in relevant laws and regulations of respective countries as well as comply with necessary technical requirements of each country.

ARTICLE 6

Notwithstanding anything contained herein, any country may enter into separate arrangements between themselves or with third countries on power trading for the benefit of their respective countries.

ARTICLE 7

Any difference regarding interpretation and application of this Agreement shall be resolved by mutual consultation among the Governments.

ARTICLE 8

This Agreement shall be subject to ratification and shall enter into force on the date of exchange of instruments of ratification. It shall remain valid for a period of fifty (50) years from the date of its entry into force and its validity shall be extended by mutual consent.

ARTICLE 9

The provisions of this Agreement shall be reviewed at ten (10) years interval or earlier as required by any Government and amended, if required, by mutual consent.
Initialed in _____ on _____ in four (4) original copies in English language.

On behalf of His Majestys Government of Nepal

_____

On behalf of the Government of India

_____

On behalf of the Government of Bangladesh

_____

On behalf of the Government of Bhutan

_____

B.2 INTER-GOVERNMENTAL MEMORANDUM OF UNDERSTANDING

WHEREAS, a closer regional power co-operation through a Power Exchange for South Asia for many years has been a priority task for the electricity sub-sector in the region; and

WHEREAS, the national power utilities in South Asia are engaged in the electricity supply business in their own countries; and

WHEREAS, the said utilities wish to continue with the development of interconnections between their respective networks, and expand capacity and energy trade among themselves; and

WHEREAS, the said utilities desire to participate in a regional power exchange under the name of the South Asia Power Exchange (SAPX) to reduce investments and operating costs, enhance reliability of supply and share in the other benefits resulting from the interconnected operation of their systems; and

WHEREAS, the said utilities wish to provide further opportunities to coordinate the installation and operation of generation and transmission facilities; and

WHEREAS, the said utilities' participation in the SAPX shall in no way change the existing relationship between the utility and the Government of the country in which the utility operates.

NOW THEREFORE the Governments who are signatories of this Memorandum of Understanding agree as follows:

ARTICLE 1: PURPOSE OF THIS MEMORANDUM OF UNDERSTANDING

The purpose of this Memorandum of Understanding is to establish a framework under which the signatories pronounce their clear intention to enhance regional power co-operation through the establishment and operation of the South Asia Power Exchange.

The basis for this regional Power Exchange is the need for all participants:

(a) To coordinate and cooperate in the planning and operation of their systems to minimize costs while maintaining reliability, autonomy and self-sufficiency to the degree they desire; and
(b) To fully recover their costs and share equitably in the resulting benefits, including reductions in required generating capacity, reductions in fuel costs and improved use of hydroelectric energy.

ARTICLE 2: DEFINITIONS

In this Memorandum of Understanding, unless inconsistent with or otherwise indicated by the context:

"Member State" means a the government representatives each of which is a member of the South Asia Power Exchange consisting of India, Bangladesh, Nepal and Bhutan;

"Non Member State" means a country that is not a member of the South Asia Power Exchange;

"SAPX" means the South Asia Power Exchange;

"Party" means a Government that is a signatory to this Memorandum of Understanding.

ARTICLE 3: DEPOSITORY OF THE MEMORANDUM OF UNDERSTANDING

3.1 The original of this Memorandum of Understanding shall be deposited with the Coordination Center of the South Asia Power Exchange, which shall act as Depository.

3.2 The Depository shall transmit certified copies to all Parties and shall notify all Parties of further Signatories of this Memorandum of Understanding.

3.3 Any notification or communication in terms of, or in regard to, this Memorandum of Understanding shall be made through the Depository.

ARTICLE 4: AUTHORITIES RESPONSIBLE FOR IMPLEMENTATION

4.1 Each Party shall designate a person responsible for the implementation of its obligations under this Memorandum of Understanding and shall notify the Depository in writing of such a designation.

4.2 If necessitated by circumstances, the persons designated under Article 4.1 by the Parties may consult with each other in regard to any problem arising from the implementation of this Memorandum of Understanding or the performance of a Party's obligations in terms of this Memorandum of Understanding.

ARTICLE 5: AUTHORITY FOR PARTICIPATION

5.1 The intention of each Party is to authorize its national power utility, created in terms of its own legislation, to enter into the necessary agreements that regulate the establishment and operation of the SAPX under the condition that these agreements are subject to the necessary approvals in accordance with the national administrative and legislative mechanisms that regulate the relations between each Government and its respective national power utility.

5.2 The Parties should endeavor to refrain from passing legislative or administrative

measures that can prevent its national power utility from fulfilling its obligations to the SAPX.

5.3 The Parties intend to co-operate with and assist their respective national power utilities in the performance and execution of their obligations in terms of any agreement entered into between the respective utilities pursuant to this Memorandum of Understanding.

ARTICLE 6: IMPLEMENTATION

6.1 This Memorandum shall enter into force upon signature by at least three (3) Member States.

6.2 The inclusion of other Non-Member States in the SAPX shall be subject to the approval of the Parties. The terms for such inclusion shall be set forth in separate agreements, which shall form part of this Memorandum of Understanding.

ARTICLE 7: SETTLEMENT OF DISPUTES

Any dispute arising between and among two or more Parties from the interpretation or application of this Memorandum of Understanding that cannot be settled amicably shall be referred to arbitration as agreed upon by the Parties. The ruling given by the arbitrator shall be accepted by the Parties as final and binding.

This Memorandum of Understanding constitutes the entire understanding between the Parties.

IN WITNESS WHEREOF, the undersigned, being duly authorized thereto, have in the names of the respective Governments signed this Memorandum of Understanding.

For the Government of India

For the Government of Bangladesh

For the Government of Bhutan

For His Majestys Government of Nepal

Appendix C Regional Power Trade Treaty (Exemplary– Central America)

The following is a draft treaty based on the recent regional trade treaty developed for implementing regional power exchange in Central America.

Regional Power Trade Treaty

The governments of India, Bangladesh, Nepal and Bhutan, each hereinafter referred to as "Member Country" or "Party" and, collectively, "Member Countries" or "Parties", agree as follows:

RECITALS

Considering that, within the framework of the South Asia Regional Initiative/Energy Program ("SARI/Energy"), the Parties have manifested the desire to initiate a gradual integration process of electrical power systems and clean fuel systems such as natural gas, through the use of the development of a competitive regional electrical power and natural gas market, by using transmission lines that will interconnect national networks, and the promotion of regional electrical generation and natural gas supply projects ("South Asia Integration System" or "SAIS");

Aware of the fact that a regional electrical and gas market supported by an interconnection of the Parties' national electrical and gas systems would promote the development of the electrical and gas industry thereby benefiting all the inhabitants of the Member Countries;

Secure in the knowledge that the consolidation of a regional electrical and gas market shall allow increasing electrical and gas transactions, and will satisfy efficiently the needs of a sustainable development in the region of South Asia, within a framework of respect and protection for the environment; and

Keeping in mind that the Parties declared that, for regional electrical systems, promoting the development of the SAARC grid was a maximum priority.

The Member Parties have agreed to sign this Treaty for the South Asia Integration System ("Treaty") that shall be governed by the following:

OBJECTIVE OF THE TREATY:

ARTICLE 1 – The objective of this Treaty is to facilitate the formation and staged growth of a regional competitive electrical and gas regional market, hereinafter referred to as "the Regional Market", based on a reciprocal and non-discriminatory treatment that will contribute to a sustainable regional development, within a framework of respect and protection for the environment.

PURPOSE OF THE TREATY:

ARTICLE 2 – The purpose of this Treaty is:

a) Establish the rights and obligations of the Parties.

b) Establish conditions for growth within the Regional Market that will deliver in a timely and sustainable manner the necessary electricity and gas for economic and social development.

c) Encourage a greater and more competitive private participation in the electrical and gas sectors of the Member Countries.

d) Promote the necessary interconnection infrastructure for the development of the Regional Market.

e) Create the necessary conditions that will bring about acceptable levels of quality, reliability, and security in supplying electrical energy and gas in the region.

f) Establish objective rules that are transparent and non-discriminatory to regulate the administration of the regional electrical and market and relations among the participating regional market agents, one entity designated by each of the Parties ("Regional Market Agents"), as well as the creation of other appropriate regional entities with the intention of attaining these objectives.

g) Promote the benefits derived from a regional electrical and gas market so that they reach all of the inhabitants of the Member Countries.

PRINCIPLES THAT GOVERN THE TREATY:

ARTICLE 3 – The Treaty shall be governed by the principles of competition, progressive implementation and reciprocity, defined as follows:

Competition:

Freedom to develop activities related to providing services based on objective rules that are transparent and non-discriminatory.

Progression:

Precautions for the progressive evolution of the Regional Market by having new participants join, progressive increase of coordinated operations, development on interconnecting networks, and strengthening of regional organizations

Reciprocity:

The right of each Party to apply the same rules and regulations to another Party, which that Party applies temporarily according to the principle of progression.

REGIONAL ELECTRIC AND GAS MARKET

ARTICLE 4 – The market operates as a permanent activity for electrical and gas commercial transactions, with short-term interchanges derived from the delivery of electrical energy and gas with regional economic criteria and by the use of mid and long-term contracts among the Regional Market Agents. The Regional Market should evolve gradually from an initially limited situation towards a broader, open and more competitive one, supported by the existing and future national as well as regional infrastructure.

ARTICLE 5 – Regional Market activities shall be undertaken by the Regional Market Agents, which could include representatives of companies dedicated to generation, transmission, distribution or marketing of electricity and gas, as well as large consumers.

Regional Market Agents shall be able to freely and without discrimination carry out the purchase and sale of electrical energy and gas. However, while the legislation of a particular country allows for the same company to carry out two or more activities related to providing electrical and gas services, or designating just one company to perform transactions in the Regional Market, these companies should create separate business units that allow a clear identification of the cost of each activity. Participation of Regional Market Agents in the Regional Market shall be governed by rules, protocol, and regulations as contained in this Treaty.

ARTICLE 6 – The Parties shall endeavor for the Regional Market to evolve towards more competitiveness by carrying out joint evaluations at least every two years based on the recommendations of SARI through the formation of a Regional Committee for Electrical and Gas Interconnections. This organization is created in Article 18 of this Treaty.

REGIONAL GENERATION OF ELECTRICITY AND GAS SUPPLY:

ARTICLE 7 – Electrical and gas transactions shall be carried out by generators and suppliers of electrical and gas systems produced in the Regional Market and designated as Regional Market Agents.

ARTICLE 8 – Electrical generation and gas plants and facilities shall be installed in any of the Member Countries, while complying with the requirements demanded by the legislation of that Member Country.

ARTICLE 9 – Each Party shall establish conditions that are favorable for the development of regional electrical generation and gas plants and facilities, consistent with the efficient development of the Regional Market.

ARTICLE 10 – A regional operating entity ("Regional Operating Entity", or "ROE"), a regional organization created by Article 18 of this Treaty, in coordination with the Regional Committee for Electrical and Gas Interconnections, shall carry out the coordinated operations of the electrical and gas systems based on the criteria of an economic delivery.

REGIONAL TRANSMISSION

ARTICLE 11 – Regional transmission is considered to be the flow of electric energy and natural gas that crosses borders between countries, allowing Regional Market transactions by means of the existing systems and networks as well as those that will be constructed in the future.

ARTICLE 12 – The Regional Market Agents shall freely access regional as well as national transmission networks. Costs for the use and availability of regional networks shall be approved by the Regional Committee for Electrical and Gas Interconnections, and the costs for use and availability of the national networks shall be approved by the national regulating entity that shall not practice discrimination in its use regionally.

ARTICLE 13 – The activity of the regional transmission companies shall be the regional transmission or transport of electrical energy and natural gas, or such other fuel subsequently determined by the Member Countries to be a "Clean Fuel".

ARTICLE 14 – The Regional Market Agents, according to methods approved by Regional Committee of Electrical and Gas Interconnections, shall cover the compensation for availability and use of regional networks.

ARTICLE 15 – Each government shall designate a public entity in their country that shall participate in a publicly or privately funded company, with the aim of developing, designing, financing, constructing and maintaining a first regional transmission system that will interconnect the electrical systems and gas networks of the Parties. None of the Parties shall have direct or indirect control of such an entity. This company, called the "Owner Company of the Network" ("OCN") shall be governed by private law and shall have legal domicile in one of the Parties' countries.

ARTICLE 16 – According to the legal procedures of each country, each government of a Member Country shall grant the respective permission, authorization and concession, depending upon the OCN's responsibilities, in relation to the construction and exploitation of the first regional transmission system and network. This company shall have a lifetime of up to thirty years that may be extended by the Parties.

ARTICLE 17 – According to the legal procedures of each country, each government of a member Country agrees to grant authorization, permits and concessions as necessary for future expansions of OCN's regional transmission networks as well as other regional transmission companies.

REGIONAL ORGANIZATIONS:

ARTICLE 18 - With the intention of obtaining an improved and more effective compliance with the purposes and objectives of this Treaty, and to organize the interrelations among the Regional Market Agents of the Regional Market, the following regional organizations are created: the Regional Committee of Electrical and Gas Interconnections, the Regional Operating Entity (ROE) and the Owner Company Network (OCN).

REGIONAL COMMITTEE FOR ELECTRICAL AND GAS INTERCONNECTION:

Article 19 – The Regional Committee of Electrical and Gas Interconnections is the regulating entity of the Regional Market with its own legal status as well as international public law legal standing applicable to the Parties. It shall be domiciled in one of the Parties' countries as defined by the governments of the Member Countries. Its duration is that of this Treaty.

ARTICLE 20 – The Regional Committee of Electrical and Gas Interconnections shall have sufficient legal standing to act in a judicial as well as extra judicial manner, and to carry out all necessary and advisable acts, contracts, and necessary or advisable operations to comply with its purpose, not only within but also outside of the territory of the signatories of this Treaty, while respecting the principles that satisfy public interest in addition to equality, free competition and publicity.

ARTICLE 21 – In order to comply with its objectives and functions, the Regional Committee of Electrical and Gas Interconnections shall consist of a commissioner from each of the Member Countries named by his respective country for a period of five (5) years extendable. The Regional Committee of Electrical and Gas Interconnections shall rely on whatever technical and administrative organizations that it requires.

ARTICLE 22 – The regional objectives of Regional Committee of Electrical and Gas Interconnections are as follows:

a. To enforce the compliance, protocols, regulations, and other complementary instruments of this Treaty.

b. Endeavor to develop and consolidate the Regional Market, as well as ensure its transparency and proper operation.

c. Promote competition between the Regional Market Regional Market Agents.

ARTICLE 23 – Regional Committee of Electrical and Gas Interconnection's authority is, amongst others, as follows:

a. Regulate the Regional Market functions by issuing the necessary regulations.

b. Take whatever regional and specific measures are necessary with the intention of guaranteeing competitive conditions and non-discrimination in the Regional Market.

c. Adopt decisions that will bring about Regional Market development, assuring its initial functioning and its gradual evolution towards a more competitive situation.

d. Approve the regulations of the physical and economic delivery as proposed by the ROE.

e. Regulate all aspects concerning regional supply and transmission.

f. Resolve authorizations as established by the Treaty according to its regulations.

g. Adopt whatever measures are conducive to avoid abuse on the part of any Regional Market Agent in a position of dominance in the Regional Market.

h. Impose sanctions that are established by protocol with relation to non-compliance with provisions and regulations of the Treaty.

i. Approve rates for the use of the regional transmission system and network according to the corresponding regulations.

j. Resolve conflicts between Regional Market Agents that result from the application of this Treaty.

k. Authorize the companies designated by each Party as Regional Market Agents of the Regional Market.

l. Approve the operational service costs of the system provided by ROE in keeping with the corresponding regulations.

m. Evaluate the Regional Market's evolution periodically, and propose to the Parties whatever measures it deems advisable in order to advance consolidation of the Regional Market.

n. Solicit audited accounting information of the business units as established by Article 5.

o. Coordinate with national regulatory organizations as to necessary measures for proper functioning of the Regional Market.

ARTICLE 24 – Funds required for operating Regional Committee of Electrical and Gas Interconnections shall come from charges on regulations as well as other charges paid by the Regional Market Agents, Government contributions, economic sanctions, interest from commercial transactions, donations and transfers from public or international organizations, funds or resources assigned by law and regulations, in addition to goods or rights acquired by onerous or gratuitous title.

The mechanism to set the cost of regulation and overseeing charges shall be established in the corresponding protocol.

REGIONAL OPERATING ENTITY:

ARTICLE 25 – ROE is the Regional Market's regional operating entity with it's own legal status as well as international public law status, applicable to the Parties. It shall be domiciled in one of the Member Countries as defined by the Parties; it's duration is as defined by this Treaty.

ARTICLE 26 – ROE has the legal status to acquire rights and contract obligations, act in a judicial as well as extra judicial manner, and carry out all necessary and advisable acts, contracts, and operations that comply with its purpose, not only within but also outside of the territory of the signatories of this Treaty, while respecting the principles that satisfy public interest in addition to equality, free competition and publicity.

ARTICLE 27 – In order to comply with it's functions and objectives, the ROE shall be directed by a Board of Directors composed of two Directors from each Party named by their respective Governments, or proposed by the Regional Market Agents of the Regional Market from each country, for a period of five (5) years. Based on protocol or this Treaty, the Parties may provide a different structure for the Board of Directors if they consider it advisable. The ROE shall rely on whatever technical and administrative organizations that it requires.

ARTICLE 28 – The principle objectives and functions of ROE are as follows:

a. Propose Regional Market operating procedures as well as the use of regional transmission networks to Regional Committee of Electrical and Gas Interconnections.

b. Assure that regional energy operations and delivery are performed using economic criteria, endeavoring to achieve adequate levels of security, quality and reliability.

c. Carry out commercial procedures of transactions between Regional Market Regional Market Agents.

d. Support the process of evolution of the Regional Market by supplying information.

e. Devise an expansion plan indicative of regional generation and transmission, foreseeing the establishment of regional reserve margins, and provide it to Regional Market Agents.

ARTICLE 29 - Funds required for running ROE shall come from service charges of the operation of the system as approved by Regional Committee of Electrical and Gas Interconnections, as well as other charges paid by Regional Market Agents, economic sanctions, interest from commercial transactions, donations and transfers from public or international organizations, funds or resources assigned by law and regulations, as well as goods or rights acquired by onerous or gratuitous title.

AUTHORIZATIONS:

ARTICLE 30 – Public entities from Member Countries dedicated to any activity related to the generation, distribution and marketing of electrical energy are hereby authorized to:

a. Join as Regional Market Agents.

b. Buy and sell energy on a short-term basis following Regional Market rules.

c. Sign long-term energy trade contracts in the Regional Market by means of a bidding process.

ARTICLE 31 - Public entities from Member Countries dedicated to any activity related to the generation, transmission, distribution and marketing of electrical energy and natural gas are hereby authorized to:

a. Purchase on the international market whatever clean fuel is necessary to generate electricity and other fuel supply needs.

b. Subscribe to the purchase of stock from the company or joint venture of companies that constructs the first regional interconnecting lines, and effect these contributions in cash and not in financial instruments, such as land, easement rights, designs, topography and others.

c. Subscribe to contracts in order to guarantee payments for the remuneration of the regional transmission networks.

d. Pay the corresponding charges for normal operations of regional organizations created by this Treaty.

GOVERNMENT COMMITMENTS:

ARTICLE 32 – The governments of the Member Countries:

a. Guarantee free transfer of electrical energy and natural gas through their respective territories for themselves or for third party countries in the region, subject only to the conditions, protocols, and regulations established in this Treaty.

b. Declare a matter of public interest whatever electrical and gas infrastructure works are necessary for the regional electrical and gas market activities.

c. Exempt taxes that discriminate in the Regional Market for import or export traffic transactions of electrical energy and gas between its countries.

RESOLUTION OF CONTROVERSIES:

ARTICLE 33 – Regional Market Agents will endeavor to reach agreement on the interpretation and application of this Treaty, and will strive to find a mutually satisfactory solution for any controversy that might affect proper functioning of the system.

ARTICLE 34 – Controversies that arise among Regional Market Agents who are a part of the Regional Market and cannot be resolved by means of negotiations, shall be sent to Regional Committee of Electrical and Gas Interconnections for final resolution.

ARTICLE 35 - Controversies that arise between governments of Member Countries with respect to the interpretation and application of this Treaty that are not resolved by means of negotiations, upon request of one or another of the disputing Parties, shall be sent for arbitration to a court or to such other organization as agreed to by the Parties for final resolution.

PROTOCOLS:

ARTICLE 36 – In order to facilitate the compliance and proper application of the provisions contained within this Treaty, the Parties will endorse the necessary protocols that will be found within the framework of the final principles and other provisions of this Treaty.

PRIVILEGE AND IMMUNITY:

ARTICLE 37 – Officials of the Regional Committee of Electrical and Gas Interconnections and ROE will be entitled, within the territory of the Member Countries of the Regional Market, to the privileges and immunities that are agreed upon by means of the observance of protocol, without prejudice to that which is established in this Treaty.

VALIDITY, RATIFICATION, ACCESSION, REGISTRATION AND TERMINATION:

ARTICLE 38 – The present Treaty shall be subject to ratification and shall remain subject to accession from other Parties.

A regional office of the South Asia Integration System ("SAIS Office") shall be established and be the repository of instruments referred to in the previous paragraph.

The timeframe of this Treaty shall be indefinite, and it shall be in effect eight (8) days after the date of the filing of the ratification instrument.

For each Party that ratifies this Treaty or accesses to it after having filed or received the second ratification instrument, the Treaty shall go into effect eight (8) days after said Party has filed its ratification or accession instrument.

The SAIS Office, as repository of the Treaty, shall send certified copies to each of the Member Countries whom it will also immediately notify upon filling or receipt of each of the ratification instruments.

The present Treaty may be terminated by any of the Parties by means of a written notification to the SAIS Office, with an advanced notice of ten (10) years after the tenth year in effect.

ARTICLE 39 – In order to revise this Treaty, upon request it can be reviewed by two (2) Member Countries of the Treaty.

EXECUTION:

ARTICLE 40 – The present Treaty has been signed on five (5) equally authenticated copies.

IN WITNESS WHEREOF, the present Treaty is signed in _____ on _____.

By: _____
By: _____
By: _____
By: _____

Appendix D South Asia Regional Power Exchange Inter-Utility MOU and Constitution of the Coordination Center

The South Africa Power Pool (SAPP) has developed various agreements that serve as examples for implementing regional power trade and exchange by SARI countries. In addition to the Inter-Governmental MOU adapted from SAPP provided in Appendix B2 two additional agreements are provided: an Inter-Utility MOU and a Constitution for a Regional Control Center. Other SAPP Agreements, not included for the purposes of this report but that should be consulted in follow-on activities include: Agreement between Operating Members, Operating Guidelines, Short Term Market Agreement (STEM) and STEM Book of Rules.

INTER UTILITY MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (MOU) is made and entered into by the signatories. Those signatories that are also Electricity Supply Enterprises are referred to as "Members".

RECITALS

WHEREAS, the national electric power utilities in India, Bangladesh, Nepal and Bhutan ("Members") are engaged in the electricity supply business in their own countries; and

WHEREAS. the Members wish to continue with the development of interconnections between their respective networks and expand capacity and energy trade among themselves; and

WHEREAS, the Members desire to participate in a regional power exchange under the name of the South Asia Power exchange (SAPX) to reduce investments and operating costs, enhance reliability of supply and share in the other benefits resulting from the interconnected operation of their systems; and

WHEREAS, the Members wish to provide further opportunities to coordinate the installation and operation of generation and transmission facilities in their respective networks; and

WHEREAS. the Members wish to cooperate and seek mutually beneficial arrangements wherever possible and to refrain from arrangements that would be detrimental to any Member or Members; and

WHEREAS, the Members accept that their relationship be based on the following principles:

(a) That issues related to interconnections be handled in a spirit of cooperation and in a friendly, open and trusting manner;
(b) That Members have equal rights and equal obligations, act in solidarity and refrain from taking advantage of each other.

NOW THEREFORE, the Members agree to enter into this MOU for the formation of the "South Asia Power Exchange" hereinafter called the "SAPX" or "Exchange".

ARTICLE 1: OBJECTIVES AND PURPOSE

The objective of this Memorandum of Understanding is to facilitate the establishment of the South Asia Power Exchange (SAPX) that, in turn, has the objective to provide reliable and economical electric supply to the consumers of each of the Members consistent with reasonable utilization of natural resources and effect on the environment.

The purpose is to establish the basic principles under which the SAPX will operate, inter alia:

(a) the coordination of and the cooperation in the planning and operation of the various systems to minimize costs while maintaining reliability and,

(b) the full recovery of costs and the equitable sharing of the resulting benefits.

Among the benefits that will be achieved, are reductions in required generating capacity, reductions in fuel costs and improved use of hydroelectric energy.

Each Member has the right and obligation, regardless of size or type of organization, to own or otherwise provide the facilities required to provide its electric service requirements.

Each and all of the provisions of this Memorandum of Understanding, are considered necessary to enable the signatories to this Memorandum to accomplish the objectives.

ARTICLE 2: HIERARCHY OF THE DOCUMENTS GOVERNING THE SAPX

The following documents shall govern the establishment and administration of the SAPX. in case of inconsistency the first document shall have precedence over the second document; the second document over the third document and the third document over the fourth document.

(i) The Inter-Government Memorandum of Understanding.

(ii) The Inter-Utility Memorandum of Understanding.

(iii) The Agreement between Operating Members.

(iv) The Operating Guidelines.

No other document can be construed as governing the establishment and the administration of the SAPX.

ARTICLE 3: DEFINITIONS

In addition to the definitions given below, definitions of terms directly related to the operation of the SAPX are given in the Agreement between Operating Members. Those definitions shall apply if the need arises to obtain the meaning of a term that is defined in the Agreement between Operating Members, but not in this MOU.

3.1 ELECTRICITY SUPPLY ENTERPRISE:

An Electricity Supply Enterprise shall mean an entity which operates a Control Center around the clock; which owns - or controls through other means - the operation of several generating units and regularly operates such units to meet a portion or all of its load obligations; which owns a transmission system already interconnected internationally with neighboring Electricity Supply Enterprise(s) or which may be interconnected with such Electricity Supply Enterprise(s) some time in the future (see also Independent Power Producers, Article 3.2).

3.3 INDEPENDENT POWER PRODUCER:

Independent Power Producer shall mean the operator of a generating facility connected to the SAPX grid. Independent Power Producers may participate in the Operating and Planning Subcommittees, but not in the Management or Executive Committees of the SAPX.

3.4 AGREEMENT BETWEEN OPERATING MEMBERS:

Agreement between Operating Members shall mean an Agreement entered between the Members that have their systems interconnected and which is part of the Operating Subcommittee. Such Members shall be referred to as Operating Members.

3.5 OPERATING MEMBER:

Operating Member shall mean a Member that has its system interconnected internationally with at least one other Member and which is a signatory of the Agreement between Operating Members.

3.6 POWER EXCHANGE PLAN:

Power Exchange Plan shall mean an overall expansion program of the Members' systems that takes into account possible synergy between these systems. The Power Exchange Plan shall be prepared by the Planning Subcommittee in accordance with Article 13.2.2. The Power Exchange Plan shall be purely indicative and shall not create an obligation upon the Members to comply.

ARTICLE 4: MANAEGEMENT STRUCTURE OF THE SAPX

The Management Structure of the SAPX is given in Figure 1.

4.1 SAPX ENERGY MINISTERS AND OFFICIALS

The SAPX Government Ministers and Officials shall be responsible for policy matters which are normally under their control in terms of the national administrative and legislative mechanisms that regulate the relations between the Government and its respective power utility.

The Executive Committee shall refer matters such as requests for membership by non-SAPX countries and major policy issues that may arise to the SAPX Energy Ministries.

4.2 EXECUTIVE COMMITTEE

The Executive Committee shall be composed of the Chief Executives of only those Member Electricity Supply Enterprises who generate, wholesale and retail power to end-use customers. Independent Power Producers shall not be eligible to participate in the Executive Committee. The Committee shall act as the Board of the Power Exchange and its duties are described in Article 10. Every Chief Executive shall continue to report to his own Controlling Body and the creation of the SAPX shall in no way alter or modify this relationship. A country having more than one utility meeting these requirements should designate one utility to represent it on the Executive Committee.

4.3 MANAGEMENT COMMITTEE:

The Management Committee shall oversee the administration of the Power Exchange and shall ensure that the objectives of the Power Exchange, as specified in this MOU, are met. Its duties are described in Article 11.5; in those areas that exceed its authority, the Management Committee shall make recommendations to the Executive Committee. Independent Power Producers shall not be eligible to participate in the Management Committee.

4.4 PLANNING SUBCOMMITTEE:

The Planning Subcommittee shall report to the Management Committee and shall be responsible for planning and other duties described in Article 13.

4.5 OPERATING SUBCOMMITTEE:

The Operating Subcommittee shall report to the Management Committee and shall be responsible for operating and other duties referred to in Article 14.

4.6 ENVIRONMENTAL SUBCOMMITTEE:

The Environmental Subcommittee shall report to the Management Committee and shall be responsible for alerting and advising the Management Committee about environmental and other matters, as described in Article 15.

4.7 COORDINATION CENTER:

The Coordination Center shall report to the Chairperson of the Operating Subcommittee. Its duties are defined in the Agreement between Operating Members.

4.8 TAU:

TAU is the Technical and Administrative Unit of the Energy Sector of SAPX. It shall provide secretarial and other services to the Executive Committee as defined in Article 12.

ARTICLE 5: COMMENCEMENT AND TERMINATION OF THIS MOU

5.1 COMMENCEMENT DATE:

An Electricity Supply Enterprise may become party to this MOU upon signature of the Inter-Government MOU by the relevant Head of State or Minister. Membership of an Electricity Supply Enterprise in the SAPX shall start on the date of signature of this MOU by its Chief Executive. The SAPX shall come into being on the date of the fourth signature of this MOU.

5.2 TERMINATION:

Any Member may terminate its participation in the SAPX by giving three (3) months notice to the Executive Committee, provided the Member is not a signatory of the Agreement between Operating Members. A Member that is a signatory of the Agreement between Operating Members, shall have the right to terminate its participation in the SAPX as specified in the Agreement between Operating Members. Any unfulfilled duties including financial obligations existing as a result of the Power Exchange at the date of termination, shall continue in full force until such items have been fulfilled or have expired.

ARTICLE 6: CONDITIONS FOR MEMBERSHIP

6.1 MEMBERSHIP:

All Electricity Supply Enterprises as defined in Article 3.3 situated in a SAPX country as of _____, and any other non-SAPX countries subject to approval of the SAPX Energy Ministers, may become a member of the SAPX. The recommendation from the Executive Committee for the acceptance of an Electricity Supply Enterprise from a non-SAPX country THAT has applied for Membership, must receive a two-thirds majority before it can be forwarded to the SAPX Ministers for approval or rejection.

6.2 OBSERVER STATUS:

By consensus or, failing this, by a two third majority the Executive Committee may grant, upon approval of the SAPX Energy Ministers, Observer status to an Electricity Enterprise interested in the interconnected operation of the Power Exchange. Electricity Supply Enterprises having obtained observer status shall all have the same rights and obligations as specified in advance by the Management Committee.

ARTICLE 7: AGREEMENTS WITH NON-MEMBERS

This MOU shall not restrict any Member from having interconnections or agreements with Non-Members provided the following conditions are met:

7.1 such agreement(s) shall not create obligations upon a Member that is not party to such agreement(s).

7.2 such agreement(s) shall not impair a Member from fulfilling its obligations under the SAPX Agreement.

7.3 unless all the affected Members have agreed beforehand, Members shall trade in electricity only with the Non-Member systems to which they are directly connected.

ARTICLE. 8: PREVIOUS AGREEMENTS

8. 1 The execution of this MOU shall not impair, amend or change any previous contract or agreement, and such contracts or agreements shall continue, including all rates, terms and conditions, until the expiration of such contracts or agreements or termination of such contracts or agreements in accordance with the provisions contained in such contracts or agreements.

8.2 If this MOU requires Members to fulfill duties that are already specified in existing agreements, nothing additional needs to be done by the Members in those specific areas.

8.3 If this MOU requires Members to fulfill duties that are only in part specified in existing agreements, only the portion of the requirements that is in excess of what is already specified in existing agreements needs be added to what must already be done by the Members.

ARTICLE 9: INTERCONNECTED TRANSMISSION FACILITIES

9.1 OWNERSHIP:

Unless otherwise agreed, each Power Exchange Member, whether an Operating Member or not, shall at its own costs, build, operate and maintain its own transmission facilities.

9.2 OPERATION:

To the extent that the Management Committee is satisfied that no use of transmission facilities will cause overload, abnormal losses, endanger the stability of the interconnected system or cause undue hardship to another Member, nothing in this MOU shall restrict a Member In the use of its own transmission facilities.

ARTICLE 10: EXECUTIVE COMMITTEE

10.1 REPRESENTATION:

The fourth signature of this MOU shall automatically create an Executive Committee consisting of the Chief Executives of eligible Members as defined in Article 4.2. It shall act as the Board of the Exchange and shall be the authority governing the administration and formulating the objectives of the SAPX .

10.2 MEETINGS:

The Executive Committee shall meet at least once a year and the Chairperson shall be from the Member hosting the meeting. The Chairmanship and the venue of the meeting shall rotate annually and meetings at other times shall be at the call of the Chair or at the request of a Member(s).

10.3 MINUTES:

A summary of the main revisions shall be prepared at the end of each meeting and signed by the Member's representatives. The minutes of the meetings shall be prepared by TAU and shall include, but shall not be limited to: a summary of all decisions made; actions taken; tasks to be carried out and all future deadlines. Copies of such minutes shall be mailed within twenty-one (21) days after each meeting to each Member of the Committee. Failure to object in writing to the minutes within thirty (30) days after mailing shall be deemed to constitute approval thereof. The minutes of all meetings shall be kept by TAU and shall be made available to the SAPX Energy Ministers for information and to all Members.

10.4 CHAIRPERSON:

The Committee shall elect a Chairperson who shall hold office for a period of at least one year, but not more than three (3) years. The Chairmanship shall rotate among the Members who are signatories of the Agreement between Operating Members.

10.5 MANAGEMENT COMMITTE AND SUBCOMMITTEES:

The Executive Committee shall specify and amend from time to time the duties and authority, other than set forth herein, of the Management Committee, the Environmental Subcommittee, the Planning Subcommittee the Operating Subcommittee and any Working Group or Task Force which may be established by the Executive Committee.

10.6 OTHER MATTERS:

The Executive Committee shall decide within sixty (60) days on any matter referred to it by a Member(s) or by the Management Committee, including the exclusion of a Member(s).

10.7 ACCEPTANCE OF NEW MEMBERS:

The Executive Committee shall, upon the approval of the SAPX Energy Ministers, accept new Members into the SAPX as specified in Article 6.1.

10.8 GRANTING OF OBSERVER STATUS:

The Executive Committee shall have the authority, upon approval of the SAPX Energy Ministers, to grant observer status to Electricity Supply Enterprises that may apply as defined Article 6.2. The granting of Observer status shall allow the Electricity Supply Enterprise to attend meetings and participate, but it shall have no voting rights in any of the committees or Subcommittees.

10.9 COMMITTEE EXPENSES:
Each Member represented at the Executive Committee shall arrange and finance the participation of its own representative{s) in the various committees, task forces and Subcommittees. TAU shall arrange and finance the participation of its own representative(s).

10.10 DECISION PROCDURES:

10.10.1 Each Member shall have one vote at the Executive Committee.

10.10.2 Decisions will be made by consensus or, failing this, by a two thirds majority of the Members present at the meeting, unless otherwise stated in this MOU.

10.10.3 The presence at the meeting of two thirds of the Members shall constitute a quorum.

10.10.4 Only Members that are signatories of the Agreement between Operating Members shall vote on Service Schedules and on operational issues.

10.10.5 The decisions made by the Committee shall be binding on all Members, including those that did not attend the meeting.

10.10.6 In case of a dispute between Operating Members, the matter shall be referred to Arbitration in accordance with the Agreement between Operating Members, unless another procedure is agreed to by the Members.

ARTICLE 11: THE MANAGEMENT COMMITTEE

11.1 REPRESENTATION:

The Management Committee shall consist of a maximum of three representatives per Member and these representatives shall be of sufficient seniority in their own organization to

make all relevant decisions. A Member's main representative(s) at the Planning and at the Operating Subcommittees shall also be its representatives at the Management Committee.

11.2 MEETINGS:

The Committee shall meet at least once a year. The Chairperson of the forthcoming meeting shall send notice of the meeting at least one month prior to the meeting. A final detailed Agenda shall be sent to all Members at least three weeks in advance. The date and venue of the following meeting shall be decided by the Members at each meeting.

11.3 MINUTES:

A summary of the main decisions shall be prepared at the end of each meeting and signed by the Members' representatives. Minutes shall be prepared by the Chairperson and shall include, but shall not be limited to: a summary of all decisions made; actions taken; tasks to be carried out and all future deadlines. Copies of such minutes shall be mailed within twenty-one (21) days after each meeting to each Member of the Committee. Failure to object in writing to the minutes within thirty (30) days after mailing shall be deemed to constitute approval thereof. Minutes of all meetings shall be sent to the Coordination Center.

11.4 DECISION PROCEDURES:

11.4.1 Each Member shall have one vote at the Management Committee.

11.4.2 Decisions will be made by consensus or, failing this, by a two-thirds majority of the Members present at the meeting, unless otherwise stated in this MOU.

11.4.3 The presence at the meeting of two thirds of the Members shall constitute a quorum.

11.4.4 Only Members that are signatories of the Agreement between Operating Members shall vote recommendations pertaining to Service Schedules and on operational and planning issues affecting interconnected operations.

11.4.5 The decisions made by the Committee, shall be binding on all Members, including those that did not attend the meeting.

11.4.6 In case of a dispute between Members that cannot be resolved by this Committee, the matter shall be referred to the Executive Committee or Arbitration in accordance with the Agreement between Operating Members.

11.5 DUTIES OF THE MANAGEMENT COMMITTEE:

The duties of the Management Committee shall include, but shall not be limited to the following:

11.5.1 Oversee the work and approve the recommendations of the Subcommittees.

11.5.2 Make all decisions on those matters not specifically delegated to other Committees.

11.5.3 Organize the training of the staff that will handle Power Exchange interactions.

11.5.4 Direct the Operating, Planning and Environmental Subcommittees to establish, working groups or task forces as required.

The following duties shall be carried out only by the Operating Members:

11.5.5 In accordance with the directives of the Operating Members of the Executive Committee, establish a Coordination Center that will provide day-to-day information and administrative services to the Operating Members in order to assist them in the implementation of the Agreement between Operating Members.

11.5.6 Establish and oversee the implementation of common accounting procedures for transactions, capacity deficits and energy deficits to determine the inter-utility payments resulting from the Agreement between Operating Members.

11.5.7 Establish the methods, procedures and intervals of reporting scheduled and actual capacity and energy interchanges.

11.5.8 Establish methods and procedures for accounting and billing for capacity and energy interchanges.

11.5.9 Ensure the collection and analysis of the data relevant to the operation and planning of the interconnected system,

11.5.10 Ensure that suitable computer hardware and software and sufficient communication facilities are available to the Members and to the Coordination Center to perform their duties.

11.5.11 Recommend to the Executive Committee the introduction of new Service Schedules, the removal of unnecessary Service Schedules and the revision as necessary, of existing Service Schedules.

11.6 CHAIRPERSON

The Committee shall elect a Chairperson who shall hold office for a period of at least one year, but not more than two (2) years. The Chairmanship shall rotate among the Members who are signatories of the Agreement between Operating Members.

11.7 DUTIES OF THE CHAIRPERSON:

11.7.1 The Chairperson shall provide an Agenda and preside over the Committee meetings.

11.7.2 The Chairperson shall bear overall responsibility for the Committee's activities and shall act as its spokesman.

11.7.3 The Chairperson shall decide whether the entire meeting or any part of it should be limited to those having Member status.

11.7.4 The Chairperson shall nominate a representative to serve as an observer at any relevant Committee meeting.

11.7.5 The Chairperson shall notify, in writing, all appointed Chairpersons and representatives to existing or new committees, working groups, or task forces created by the Management Committee.

11.7.6 The Chairperson shall invite participation of other utilities, organizations or experts as required.

11.7.7 The Chairperson shall maintain records of the proceedings of the Management Committee. After the establishment of the Coordination Center, these records shall be retained at the Coordination Center to be available to all Members on request.

ARTICLE 12: DUTIES OF THE TECHNICAL AND ADMINSITRATIVE UNIT

The duties of TAU with respect to the SAPX shall consist of the following:

(i) To provide a secretariat to the Executive Committee.

(ii) To advise the Executive Committee of the relevant rules and regulations of SAPX.

(iii) To assist the Executive Committee in achieving SAPX objectives with regard to the establishment and development of the SAPX .

(iv) To report to the SAPX Committee of Energy Ministers.

(iv) To seek and mobilize funds as recommended by the SAPX Executive Committee.

ARTICLE 13: PLANNING SUBCOMMITTEE

13.1 REPRESENTATION:

The Planning Subcommittee shall consist of a maximum of two representatives per Member and these representatives shall be of sufficient seniority in their own organization to make all relevant decisions.

13.2 DUTIES OF THE PLANNING SUBCOMMITTEE:

The duties of the Planning Subcommittee shall include, but shall not be limited to the following:

13.2.1 Establish and update common planning and reliability standards that have an impact on the SAPX .

13.2.2 Based on individual Member's plans, develop every two years, an overall Power Exchange Plan to highlight the benefits and opportunities for cost savings that can be derived by the Members from the Coordination of activities. The Power Exchange Plans shall:

(i) Take into account the forecasted demand and energy consumption in each Member's system, including Demand Side Management.

(ii) Indicate the anticipated sales and purchases by each Member, including those with Electricity Supply Enterprises or Independent Power Producers Non-Member of the SAPX .

(iii) Contain the characteristics, location and commissioning dates of the new generating units and new transmission facilities of ___ KV and above which are planned in each Member's system, when such facilities have a significant impact on the interconnected system.

(iv) Contain the characteristics, location and commissioning dates of the new telecommunication, telecontrol and supervisory facilities that are planned in each Member's system, when such facilities have a significant impact on the operation of the interconnected system.

(v) Identify and record new generation, transmission, telecommunication or telecontrol facilities to be installed in the systems of Members and Non-Members.

13.2.3 Evaluate software and other tools which will enhance the value of planning activities such as load forecasting, the determination of planning or reliability standards, cost-benefit analysis or system studies; submit proposals to the Management Committee.

The following duties shall be carried out only by the Operating Members:

13.2.4 Submit proposals to the Operating Members of the Management Committee regarding new Service Schedules, removal of unnecessary Service Schedules and revision as necessary of existing Service Schedules.

13.2.5 Specify the reliability standards that shall be used to determine the Accredited Capacity Obligation of each Operating Member.

13.2.6 Present a course of action that will enable each Operating Member to comply with its Accredited Capacity Obligation.

13.2.7 Establish the benefits attributable to each Operating Member resulting from the installation of relays, control equipment or any system study, improvement or facility required for the satisfactory operation of the interconnected system and make recommendations to the Operating Members of the Management Committee regarding the financial contribution of each Operating Member to the costs of such improvements.

13.2.8 Establish future transfer capability limits between systems to enable the Operating Subcommittee to prepare detailed Operating Procedures.

13.2.9 Identify specific reliability problems and recommend the generation or transmission additions or changes required to eliminate them.

13.2.10 Establish capacities of transmission plant in the system of Operating Members for the purposes of calculating wheeling rates and review these on an annual basis.

13.3 CHAIRPERSON

The Planning Subcommittee shall elect a Chairperson to serve for at least one (1) year term, but not more than two (2) years, after which the Chair shall rotate to other Members. The Chairperson shall be elected from the Operating Members of the SAPX .

13.4 ADMINISTRATIVE MATTERS:

The rules governing the meetings, minutes, decision procedures, duties, election and tenure of the Chairperson of the Planning Subcommittee, shall be the same as for the Management Committee.

In case of disagreement between Members, the matter shall be submitted to the Management Committee. The report shall reflect the majority view and include a statement by the minority.

ARTICLE 14: OPERATING SUBCOMMITTEE

14.1 REPRESENTATION:

The Operating Subcommittee shall consist of representatives of Members that are signatories of the Agreement between Operating Members. It shall have a maximum of two representatives per Member and these representatives shall be of sufficient seniority in their own organization to make all relevant decisions. The main representative shall also be a participant in the Management Committee.

14.2 DUTIES OF THE OPERATING SUBCOMMITTEE:

The duties of the Operating Subcommittee shall be in accordance with the Agreement between Operating Members.

14.3 CHAIRPERSON:

The Operating Subcommittee shall elect a Chairperson to serve for at least one (1) year term, but not more than two (2) years, after which the Chair shall rotate to other Members.

14.4 ADMINISTRATIVE MATTERS:

The rules governing the meetings, minutes, decision procedures, duties, election and tenure of the Chairperson of the Operating Subcommittee, shall be the same as for the Management Committee.

In case of disagreement between Members, the matter shall be submitted to the Management Committee. The report shall reflect the majority view and include a statement by the minority.

ARTICLE 15: ENVIRONMENTAL SUBCOMMITTEE

15.1 REPRESENTATION:

Each Member shall appoint one representative to the Environmental Subcommittee.

15.2 MEETINGS:

The Environmental Subcommittee shall hold an annual meeting in the first quarter of each calendar year and shall hold other meetings at the call of the Chairperson or at the request of

any Member. At least one (1) month written notice shall be given of any meeting and shall state the time and place of the meeting and include an agenda of the items to be considered.

15.3 CHAIRPERSON:

The Environmental Subcommittee, at its annual meeting, shall elect a Chairperson to serve for at least a one (1) year term, but not more than two (2) years, after which the Chair shall rotate to the other Members.

15.4 DUTIES:

Under the direction of the Management Committee, the Environmental Subcommittee shall keep abreast of world and regional matters relating to air quality, water quality, land use and other environmental issues. Where Governments have in place related Environmental Organizations, this Committee shall liaison with them to assist one another on specific issues. The Subcommittee shall present all findings and recommendations to the Management Committee, the Planning and Operating Subcommittees and shall also carry out other functions and activities as assigned or approved by the Management Committee.

ARTICLE 16: COORDINATION CENTER

16.1 CREATION OF THE COORDINATION CENTER:

The representatives of the Operating Members at the Management Committee shall propose the creation of a Coordination Center to the representatives of the Operating Members at the Executive Committee. The functions and duties of the Coordination Center, when it is established, shall be in accordance with the Agreement between Operating Members.

16.2 CONTRIBUTIONS TO COSTS BY NON-OPERATING MEMBERS

Since Members that are not signatories of the Agreement between Operating Members will nevertheless benefit from the Coordination Center by obtaining information and other services from it, they shall contribute to the costs of the Coordination Center in accordance with the rulings of the Management Committee. Non-Members may also receive information from the Coordination Center, but shall pay market rates for such information.

ARTICLE 17: AMENDMENTS

This MOU may be reviewed from time to time, but no modification shall be of any force or effect unless reduced to writing and approved by the Executive Committee.

ARTICLE 18: ASSIGNMENT

Each Member shall have the right to assign this MOU to any successor to all or substantially all of its electric properties, whether by merger, consolidation, sale or otherwise, without the consent of the other Members, provided such successor shall agree in writing to assume the obligations of such Member. This provision shall be applicable to assignees in succession.

ARTICLE 19: NOTICES AND DOMICILIUM

19.1 COMMUNICATION:

Any communication or documents given or sent by any Member or TAU to any other Member or TAU shall be in writing and shall be deemed to have been duly delivered to the party to which it is addressed at its respective address, namely:

(insert)

19.2 DELIVERY TIME:

19.2.1 If a communication is delivered by hand, it shall be deemed to have been received by the addressee on the date of delivery.

19.2.2 If posted by pre-paid registered post, it shall be deemed to have been received by the addressee on the fourteenth (14) day after postage.

19.2.3 If sent by telex, telegram or facsimile, it shall be deemed to have been received by the addressee one (1) day after dispatch.

19.3 CHANGE OF ADDRESS:

Any Member may, by written notice to all of the other Members, change the address to which any notice or request intended for the Member giving such notice, shall be addressed.

IN WITNESS whereof the said Operating Members have hereto set their hands:

CONSTITUTION OF THE COORDINATION CENTER

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SOUTH ASIA REGIONAL POWER EXCHANGE

CONSTITUTION OF THE COORDINATION CENTER

ARTICLE 1: PREAMBLE/RECITALS

WHEREAS, under the terms of the Memorandum of Understanding ("MOU") dated _____ that established a plan to interconnect the grids of India, Nepal, Bhutan and Bangladesh, the management structure of the regional power exchange ("SAPX") provides for a Coordination Center reporting directly to the Operating Sub-Committee of the Management Committee; and

WHEREAS, under the MOU, Operating Members of the Management Committee are empowered to establish a Coordination Center which will provide day-to-day information and administrative services to the Operating Members in order to assist them in the implementation of the South Asia Power Exchange Agreement between Operating Members dated _____; and

WHEREAS in pursuance of a directive given by Operating Members of the Executive Committee established by the MOU on _____ who resolved to establish a Coordination Center to be based in _____;

NOW THEREFORE THE OPERATING MEMBERS OF THE SAPX DO HEREBY AGREE TO ENDORSE AND BIND THEMSELVES TO THIS, THE CONSTITUTION OF THE COORDINATION CENTER.

ARTICLE 2 INTERPRETATION OF TERMS

In this Constitution:

2.1 "ABOM" means the Agreement between Operating Members of _____;

2.2 "Coordination Center" means the Coordination Center of the SAPX as defined in the ABOM;

2.3 "Executive Committee" means the Executive Committee of the SAPX as defined in the MOU;

2.4 "Financial Year" means the financial year of the Coordination Center which shall be a period of 12 (TWELVE) calendar months reckoned for the 1st of April in one calendar year and ending on the 31 s: of March in the following calendar year;

2.5 "Management Committee" means the Management Committee of the SAPX referred to in the MOU;

2.6 "Manager" means the Manager of the Coordination Center;

2.7 "Operating Member" means an Operating Member of the SAPX;
2.8 "Operating Sub-Committee" means the Operating Sub-Committee of the Management Committee referred to in the MOU; and

2.9 "SAPX" means the South Asia Power Exchange established in terms of the MOU.

ARTICLE 3: ESTABLISHMENT OF THE COORDINATION CENTER AND ITS HEAD OFFICE

There is hereby established that a Coordination Center of the SAPX to be located in _____ at a place to be agreed upon by Operating Members, which place shall serve as the Head Office of the Coordination Center.

ARTICLE 4: LEGAL STATUS OF THE COORDINATION CENTER

4.1 The Coordination Center shall be a common law body corporate capable of suing and being sued, acquiring rights and incurring obligations and generally exercising all the rights and privileges accorded to and ordinarily enjoyed by a legal entity, subject however to the provisions of this Constitution as read with the MOU and ABOM;

4.2 The Coordination center shall exist and be managed and operated solely for the common benefit of the Members and not for profit.

ARTICLE 5: MISSION STATEMENT AND OBJECTIVES OF THE COORDINATION CENTER

5.1 The Coordination Center is an organization dedicated to the effective implementation of SAPX objectives.

5.2 In order to obtain the mission, the following objects are set:

(i) to create and maintain an effective organization and infrastructure;
(ii) to promote the interest and image of the Coordination Center in any manner;
(iii) to provide and disseminate specified, applicable and current information on developments and trends in SAPX, transactions between Member and in the worldwide electricity supply industry;
(iv) to regulate, foster and maintain fair and just relationships between Members and to encourage and maintain training requirements of SAPX;
(v) to encourage research and development of new plant and methods for use in the South Asia electricity supply industry;
(vi) to advise Members on matters of common interest and concern;

(vii) to advise Members on matters affecting the relationship between themselves; and

ARTICLE 6: MEMBERSHIP

6.1 General: Membership shall be obtained by being accepted as a member of SAPX as prescribed in the MOU and being represented on the Management Committee; and paying the prescribed contributions as stipulated in the MOU read with the ABOM.

6.2 Operating Members: Operating Members will be those Members of SAPX that have signed and acceded to the ABOM. Operating Members shall be entitled to vote on all Coordination Center matters.

6.3 Non-Operating Members: Non-Operating Members will be those Members of SAPX who have signed the MOU but not the ABOM. Non-Operating Members shall be entitled to vote on all Coordination Center matters that they may vote on as members of the SAPX Management Committee.

6.4 Termination of Membership: A Member's membership shall terminate in the following circumstances: (i) if he resigns his membership by notice in writing in terms of the MOU; (ii) if any monies due and payable to the Coordination Center remain unpaid after the expiry of the prescribed time or such extended time as may be allowed by the Management Board; (iii) if a body corporate Member is de-registered and not reconstituted as another legal entity to whom its rights and obligations are assigned; (iv) if a provisional or final judicial manager, sequestration or liquidation order is granted against any Member; (v) if his membership of SAPX is terminated for any reason.

6.5 Membership Fees

6.5.1 Operating Members shall pay the contributions as determined in the ABOM. Non-Operating Members shall pay the contributions as may be determined from time to time by the Management Committee of SAPX at a General or Special General Meeting of the Coordination Center;

6.5.2 Members may be required to make additional contributions in circumstances where the Coordination Center experiences a shortage of funds as determined at a General or Special General Meeting of the Coordination Center;

6.5.3 All membership fees are due and payable on the first day of the Financial Year, failing which the provisions of the ABOM where applicable will apply; The liability of a Member is limited to the amount of its unpaid membership fees or any other amount to which the Member is indebted to the Coordination Center.

6.5.4 Failure to pay membership fees renders the Member's membership liable to be suspended or terminated by the Management Board if a Member regularly fails to pay membership fees when due; failure to pay fees disqualifies the Member from voting at any General Meeting of the Coordination Center whilst such membership fees remain unpaid.

ARTICLE7: INCOME OF THE COORDINATION CENTER

7.1 The income of the Coordination Center shall solely comprise of the contributions made by Operating and Non-Operating Members towards the operating and running costs of the Coordination Center under terms of Article 81 and 8.2 of this Constitution and any donation or grant made by any Government, organization or person.

7.2 The income of the Coordination Center, and any accrued interest accruing, shall be used solely in funding the operations of the Coordination Center and not be paid to or ensure to the benefit of any individual Member, except payment for approved services rendered to the Coordination Center by such Member.

ARTICLE 8: FINANCIAL AFFAIRS AND CONTROL

8.1 The operations of the Coordination Center, including remuneration of the staff thereof, shall be funded by Members in the manner and proportions stipulated in the ABOM.

8.2 The Manager shall be the accounting officer of the Coordination Center responsible for administering the financial affairs thereof in compliance with the provisions of the ABOM regarding, among other things, preparation of the Coordination Center's budget, keeping of income and expenditure records and the preparation and issuing of financial statements for each Financial Year.

8.3 The Coordination Center shall keep such books of accounts and employ such bookkeeping system as shall be approved by the Management Committee acting on the recommendations of the Operating Sub-Committee.

8.4 The Coordination Center shall open and operate a current bank account with such internationally recognized and registered commercial bank in _____ as shall be approved by the Management Committee acting on the recommendations of the Operating Sub-Committee.

All contributions made by Members and Non-Members towards funding the Coordination Center shall be deposited in the bank account wherefrom shall be withdrawn all moneys required for meeting the authorized expenditure of the Coordination Center.

8.5 The financial statements of the Coordination Center shall be audited annually and within 3 (THREE) months of the close of the Financial Year by a reputable and registered firm of chartered accountants appointed by the Management Committee acting on the recommendations of the Operating Sub-Committee. The audited financial statements shall be presented to the Management Committee within 6 (SIX) months of the close of the Financial Year for presentation to and consideration by the Executive Committee at its next annual meeting.

8.6 No Member or other person shall borrow money from the Coordination Center.

ARTICLE 9: POWERS, FUNCTIONS AND DUTIES

9.1 For purposes of achieving its purpose the Coordination Center shall have the power to:

(i) acquire, either by purchase, lease or otherwise, any movable or immovable property or also to sell, mortgage or otherwise deal with or dispose of movable or immovable property or other assets belonging to the Coordination Center;
(ii) institute or defend any legal action on behalf of or against the Coordination Center;
(iii) operate as an independent entity servicing SAPX;
(iv) meet the financial requirements of the Coordination Center by means of membership fees, loans, bank overdrafts, donations or grants and it shall not accept any donation that is not irrevocable and unconditional;
(v) utilize its fund solely for the object for which the Coordination Center has been established and shall not distribute any of its funds or assets to any person except as payment for goods or services;
(vi)utilize the capital and income of the Coordination Center in order to achieve the aims and objectives set out in this Constitution, provided the activities of the Coordination Center shall be wholly or mainly directed to the furtherance of its mission and objectives;
(vii)for purposes of promoting and achieving the objects and aims of the Coordination Center, receive or acquire immovable property and to sell and dispose of or, to rent or lease such property provided that the Coordination Center:

a. shall not become engaged in trading or speculative transactions;
b. operate and use banking accounts and arrange for overdraft facilities to attain the objectives of the Coordination Center;
c. administer, insure, sell, rent, bond, dispose of, exchange, develop, improve or beneficially occupy all or any of the assets of the Coordination Center;
d. secure the payment of any obligations of the Coordination Center in any way whatsoever, including the hypothecation thereof, the pledging thereof, in any or by way of cession or transfer of property or rights;

e. invest money not immediately required in any manner, to liquidate investments and to re-invest same;
f. make, issue, draw, accept, endorse or discount any promissory note or any form of negotiable instrument;
g. appoint a Manager and other employees, advisors, consultants, agents and contractors and to remunerate them and terminate their services;
h. indemnify officials and employees with regard to any damages, injuries or liabilities incurred by them in the bona fide exercise of their duties or employment;
i. take out any form of insurance with regard to its powers, functions and duties;
j. do all that may be necessary or convenient to give effect to the mission and objectives and to exercise the powers of the Coordination Center

9.2 The functions and duties of the Coordination Center shall be those specified in the ABOM, including:

(i) monitor continuously the operation of the Regional Power Exchange;
(ii) monitor transactions between Operating Members and between Members and Non-Members;
(iii) monitor time correction procedures;
(iv) monitor the inadvertent power flows and the returns in kind between the Members;
(v) provide routine daily reports, data and information relevant to the operation of the Power Exchange to the Operating Sub-Committee and to the Members;
(vi) monitor and advise on the use of the Operating Guidelines;
(vii) monitor and report on the control performance criteria, as specified in the Operating Guidelines, to all the Operating Members;
(viii) convene, following a disturbance affecting the parallel operation of the Pool, a post disturbance committee;
(ix) provide information and give technical advice to Members in matters pertaining to parallel operation;
(x) evaluate the impact of future projects on the operation of the Pool and advise the Operating Sub-Committee accordingly;
(xi) perform various operational planning studies to highlight possible operating problems;
(xii) give advice on short-term and long-term operating problems;
(xiii) perform studies to determine transfer limits on tie lines and inform Operating Members accordingly. Monitor adherence of Operating Members to these limits;
(xiv) establish and update a data base containing historical and other data to be used in Planning and System Operation studies;

(xv) monitor the availability of the communication links between the Control Centers of the Operating Members and between those Control Centers and the Coordination Center;

(xvi) advise on the feasibility of wheeling transactions;

(xvii) gather and act as the official custodian of data pertaining to transactions between Operating Members and between Operating Members and Non Members;

(xviii) monitor the protection performance of all tie lines;

(xix) carry out projects and assignments as directed by the Operating Sub Committee;

(xx) monitor the protection performance of all tie lines;

(xxi) monitor the Coordination Center-ordination of protection on all tie lines;

(xxii) monitor adherence to the Agreement by the Operating Members, inter alia regarding Accredited Capacity Obligation and calculate the penalties for insufficient Accredited Capacity and their re-allocation among Members;

(xxiii) disseminate the generation and transmission maintenance schedule received from the Operating Members and advise on the adjustments that are required to maintain at all times the contractual Pool reserves and the agreed upon services;

(xxiv) co-ordinate the training of the Members' staff and if necessary, organize training seminars focusing on the operation of the interconnected system;

(xxv) prepare and issue annually a control performance summary report for the benefit of the Operating Sub-Committee;

(xxvi) identify capital projects required by the Coordination Center and make proposals to the Operating Sub-Committee;

(xxvii) endeavor to obtain funding for the capital projects of the Coordination Center upon approval by the Operating Sub-Committee;

(xxviii) prepare and present an annual budget covering the Coordination Center expenditure for approval by the Operating Subcommittee;

(xxix) produce a monthly financial statement as specified by the Operating Sub-Committee;

(xxx) and such other functions and duties as may be lawfully assigned from time to time.

ARTICLE 10: ADMINISTRATIVE AFFAIRS

10 1 Management of the Coordination Center shall vest in a Manager appointed as provided in the ABOM who shall be answerable and accountable to the Operating Sub-Committee on the operations and performance of the Coordination Center and other related maters.

10.2 The Manager shall be entitled and empowered to recruit such personnel to man the Coordination Center on such terms and conditions as shall be approved by the Management Committee acting on the recommendation of the Operating Sub-Committee.

10.3 The Manager shall at all times keep confidential and ensure confidentiality of all information supplied by or to the Coordination Center by Members or vice versa.

10.4 The Management Committee shall, in terms of Article 1.5.10 of the MOU, ensure that suitable computer hardware and software, sufficient communication facilities and other requisite resources are made available to the Coordination Center for use in the performance of its functions and duties.

10.5 No Member shall interfere with or otherwise hinder or obstruct the management and staff of the Coordination Center in the performance their functions and duties.

ARTICLE 11: MANAGEMENT BOARD

11.1 The Operating Sub-Committee of SAPX established in terms of the MOU shall act, if specifically so convened, as the Management Board of the Coordination Center.

11.2 The chairman for the time being of the Operating Sub-Committee shall chair the meetings.

11.3 The Coordination Center shall provide secretarial services to the Management Board.

11.4 The Manager of the Coordination Center shall attend all meetings of the Management Board but have no vote.

11.5 The Management Board shall meet as often as it is deemed necessary but not less than four times during a financial year.

11.6 The Coordination Center shall keep minutes of all resolutions take, which shall be held in safekeeping and made available to Members.

11.7 Meetings shall be convened by giving not less than 10 (TEN) days written notice, provided that the chairman may call a meeting on shorter notice. The notice convening a meeting shall be accompanied by an agenda to such meeting,

11.8 The Management Board shall have the power to appoint sub-committee from amongst itself or others as it deems fit and delegate to such committees all powers and duties vested in itself.

11.9 A quorum shall be 75% of the Operating Members, which must be maintained throughout the sitting. Should a quorum not be present, the chairman shall adjourn the meeting to a place and time not less than 1 (ONE) week and not more than 1 (ONE) month thereafter. The Operating Members present at such adjourned meeting shall constitute a quorum.

11.10 Any resolution of the Management Board in writing (whether contained in one or more documents), duly signed by Management Board members constituting a quorum in terms of this Constitution, shall be valid as if the resolution had been taken at a duly constituted meeting of the Management Board, notwithstanding any other provision to the contrary contained in this Constitution.

11.11 Resolutions of the Management Board shall be binding on all Members.

ARTICLE 12: POWERS OF MANAGEMENT BOARD

12.1 In addition to any other powers conferred on the Management Board, it shall have the power to:

(i) Manage and control the affairs of the Coordination Center and do whatever it considers appropriate to achieve the mission and the objects of the Coordination Center.
(ii) Appoint accountants, auditors, lawyers, engineers, consultants and any other professional firm or person on such terms as it decides upon.
(iii) Receive funds and open and administer bank accounts on behalf of the Coordination Center;
(iv) Take the necessary measures to protect the property and rights of the Coordination Center.
(v) Execute the policy of the Coordination Center as determined by the General Meeting.
(vi) Purchase, borrow, acquire, sell, lease, mortgage or otherwise deal with, dispose of any movable or immovable property of the Coordination Center.
(vii) Enter into any agreement for and on behalf of the Coordination Center and to authorize the signing of all documentation to give effect thereto in the name of the Coordination Center.
(viii) Institute, conduct, defend, compound or abandon any legal proceeding by or against the Coordination Center.
(ix) Cooperate with any person, body, organization or association or to make agreements that promote the aims and objectives of the Coordination Center.
(x) Administer membership according to the Constitution and regulations.
(xi) Deal with any matter not specifically provided for in this Constitution in the best possible way.

ARTICLE 13: GENERAL MEETING

13.1 General

13.1.1 The Management Committee of SAPX, when specifically so convenes shall be a General Meeting or Special General Meeting of the Coordination Center.

13.1.2 The Coordination Center shall hold an Annual General Meeting within 6 (SIX) months after the end of each Financial Year.

13.1.3 The Coordination Center may hold a Special General Meeting as the Management Board may decide from time to time.

13.1.4 The Manager of the Coordination Center shall attend all General and Special General Meetings of the Coordination Center.

13.1.5 A Special General Meeting shall also be convened upon the written request of at least one third of all Members and upon at least 7 (SEVEN) days' written notice to all Members accompanied by proper notification of the purpose of such meeting.

13.1.6 All General Meetings shall be open to all Members to attend.

13.1.7 Notice of General Meetings, setting the time and the place of the meeting shall be given to all Members not later than 21 (TWENTY ONE) days before the General Meeting. The notice shall be accompanied by an agenda, which shall contain in full the motions to be considered by the General Meeting and a proxy form.

13.1.8 The Chairman of the SAPX Management Committee shall chair the General Meeting. In his absence the meeting shall appoint a chairman.

13.1.9 The proceedings at the General Meeting shall not be invalidated on the grounds that a notice has not been received by a Member, who attending the meeting.

13.1.10 The Coordination Center shall provide the secretarial services require for any General or Special General Meeting of the Coordination Center and shall keep minutes of all resolutions taken which shall be held in safe keeping and made available to Members on request.

13.2 Quorum

A quorum for meetings shall be at least 50 (FIFTY) per cent of all fully paid-up Members which must be maintained throughout. Should a quorum not be present, the Chairperson shall adjourn the meeting to a place and time not less than 1 (ONE) week and not more than 1 (ONE) month thereafter. The Members at such adjourned meeting shall constitute a quorum.

13.3.1 Voting

13.3.2 All matters before the General Meeting shall be decided by a majority vote.

13.3.3 Each member entitled to vote in terms of Article 8 shall have one vote. Only Members in good standing shall be entitled to vote.

13.3.4 Members may vote either in person or by proxy. A proxy form shall be attached to the notice of the General Meeting and all proxy forms appointing a proxy shall be returned to the Secretary and Communications Committee at least 7 (SEVEN) days prior to the date of the General Meeting.

13.3.5 Voting shall be executed by a show of hands.

13.3.6 If there is a deadlock during the vote on any resolution the following rules shall apply: (i) a second vote by ballot shall be called for by the Chairman before the close of business of the meeting; (ii) if after the second vote the vote is still deadlocked the meeting in respect of any deadlocked votes shall be adjourned to a date not later than 3 (THREE) weeks after the date of the present meeting at which meeting the only business to be conducted will be reconsideration of the deadlocked resolution, except if the Members unanimously agree to additional agenda items; (iii) if at the adjourned meeting the note remains deadlocked the deadlocked resolution will be referred by the Coordination Center Manager to the Executive Committee of SAPX for mediation between the Members in deadlock The Coordination Center Manager will prepare a summary of the proceedings to date and forward it to the Chairman of the Executive Committee and all Members;

13.3.6 The Executive Committee shall mediate on the deadlocked resolution within 30 (THIRTY) days of referral to it;

13.3.7 if the Executive Committee is unable to mediate a resolution the deadlocked resolution will be removed from the agenda and may not be reinstated on the agenda before a lapse of at least 6 (SIX) months, except in the case of the budget in which event it shall make an arbitral ruling binding on all Members.

13.4 Powers

In addition to any others powers conferred on the General Meeting it shall have the power to.

13.4.1 Adopt the audited accounts;
13.4.2 Appoint external bookkeepers or auditors for the next Financial Year and fix their remuneration;
13.4.3 Consider all motions of which due notice was given;
13.4.4 Determine the policy and strategy for the Coordination Center;
13.4.5 Adjudicate disputes between Members pertaining to matters or the activities of the Coordination Center;
13.4.6 Approve, amend, supplement or abrogate regulations, by-laws and code of conduct;
13.4.7 Discipline any Member that has made himself guilty of misconduct or acted or refrained from acting and in so doing brought the Coordination Center into disrepute;
13.4.8 Terminate the membership of any Member provided that such Member has had the opportunity' to present his case to the General Meeting for disciplinary matters regarding Members.

ARTICLE 14; SUNDRY PROVISIONS

14.1 The Management Board Members shall not be liable (individually or collectively) for any loss of capital or part thereof of the fund resulting from the exercise of the Management Board Members of any powers or discretions in terms of this Constitution, or as a result of bona fide attempts by the Management Board Members to fulfill their functions in terms of this Constitution, or as a result of a demolition in

value of the fund or any portion thereof or as a result of any shortage upon the realization of any asset of the Coordination Center, unless the Management Board Members acted in bad faith in making the investment, retaining the investment or realizing such investment or asset.

14.2 A Management Board Member shall not be liable for any unlawful act or misconduct of any other Management Board Member, unless such Management Board Member knowingly permitted such act or was an accomplice thereto.

14.3 All costs and disbursements lawfully incurred by the Management Board Members with regard to the administration of the fund, including but not limited to legal costs incurred by or against them in their capacities as such, shall be paid by the Coordination Center from the Fund.

14.4 The Management Board Members and office bearers of the Coordination Center are hereby indemnified by the Coordination Center against any claims whatsoever against the Management Board Members or office bearers away from anything done bona fide in their official capacities for or on behalf of the Coordination Center.

ARTICLE 15: AMENDMENTS

15.1 An amendment of this Constitution shall only be tabled if proposed by an Operating Member and supported in writing by at least 3 (THREE) other Operating Members and 2 (TWO) Non-Operating Members, as long as there are 2 (TWO) or more Non-Operating Members. If there are no Non-Operating Members at least 5 (FIVE) other Operating Members must support the tabling of the amendment.

15.2 This Constitution may be amended at anytime by unanimous resolution the Management Committee acting on the recommendations of the Operating Sub-Committee provided that no such amendment shall be in conflict or inconsistent with the MOU or ABOM.

ARTICLE 16: DISPUTE RESOLUTION

Any dispute or disagreement arising between the Coordination Center and any Member shall be referred by the Operating Sub-Committee to the Management Committee which shall endeavor to resolve same amicably within 10 (TEN) days of referral thereof, provided that if the Management Committee cannot for any reason resolve the dispute or if one party is aggrieved by the Management Committee's determination or ruling, the Management Committee shall, by written notice to the parties concerned, refer the matter to the Executive Committee which shall hear and finally determine the dispute.

ARTICLE 17: NOTICES AND DOMICILUM

Any notice, document or communication required to be given or sent to or served on the Coordination Center shall be addressed to the Manager at the Coordination Center’s head office which shall be the Coordination Center’s address for service.

ARTICLE 18: DISSOLUTION AND CONSEQUENCES

18.1 The Coordination Center may, at any time, be dissolved and cease to function by resolution of the Management Committee; or shall be dissolved and cease to exist, upon dissolution of the SAPX.

18.2 The dissolution of the Coordination Center in terms hereof shall not adversely affect or prejudice antecedent rights of staff or creditors of the Coordination Center acquired prior to and in existence at the time of such dissolution, which rights shall be fully enforceable against the SAPX as if it was the Coordination Center

18.3 Upon dissolution of the Coordination Center, all its assets shall be collated and realized to meet any outstanding financial obligation to creditors and the balance distributed among Operating Members or disposed of in such manner as the Operating Members shall determine.

ARTICLE 19: ENTIRE CONSTITUTION AND GOVERNING LAW

19.1 This Constitution constitutes the entire constitution of the Coordination Center and shall be read with and subject to the MOU and ABOM, and any Member who breaches the provisions hereof shall be liable to receive any of the appropriate penalties or sanctions specified in the ABOM.

19.2 This Constitution shall be governed by and construed or interpreted in accordance with the laws of _____.

IN WITNESS HEREOF THIS CONSTITUTION HAS BEEN ADOPTED BY THE MANAGEMENT COMMITTEE ON THIS THE ___ DAY OF _____ AT _____

SIGNED: CHAIRMAN, SAPX MANAGEMENT COMMITTEE

WITNESS: CHAIRMAN, OPERATING SUBCOMMITTEE

Appendix E Environmental Guidelines for Transmission Projects

E.1 TYPICAL IMPACTS RELATED TO POWER TRANSMISSION PROJECTS

E.1.1 Land Take

Electric power transmission lines have both a temporary and a permanent impact on land resources. During construction in normal conditions on flat agricultural land, a temporary right-of-way (ROW) is created. The Power Grid Corporation uses a width of 26 m from the center line (total width 52 m). This may vary slightly in upland areas. In addition there will be a land requirement for construction roads and laydown areas. Permanent land take is required for the footprint of the transmission towers and substations, for example the substation currently under construction at Siliguri occupies an area of land 450 m x 450 m.

Grazing and other agricultural uses are usually not precluded in ROWs, but other uses are generally not compatible. Although ROWS are generally not very wide, they can interfere with or fragment existing land uses along the ROW. Long transmission lines will affect more areas and result in more significant impacts.

For example, construction of a single tower with four foundation bases would typically involve:

- Excavating holes – 2 days
- Casting foundations – 1 day
- Tower erection – 2 days
- Stringing – 1 day access to site (up to 10 km in one day)

These processes may take place over the course of a month, depending upon the size of the project and the length of line being strung.

Transmission lines can open up more remote lands to human activities such as settlement, agriculture, hunting, recreation, etc. Construction of the ROW can result in the loss and fragmentation of habitat and vegetation along the ROW. These effects can be significant if natural areas, such as wetlands are affected, or if the newly accessible lands are the home of indigenous peoples.

The narrowness of the chicken neck area and its significance as a conduit to eastern India means that land take is a potentially significant issue. Population density is high and almost all available land is under agriculture.

E.1.2 Agriculture

The construction and maintenance of high voltage transmission lines across or adjacent to agricultural fields can affect farm operations in numerous ways. Depending on the placement of individual poles, routing a transmission line in an agricultural setting can:

- Create problems for turning machinery and maintaining efficient fieldwork patterns.
- Create opportunities for weed encroachment

- Compact soils and damage drain tiles Result in safety hazards and damaged machinery if collisions between equipment and poles or guy wires occur.
- Interfere with well drilling and maintenance or irrigation, where wells are close to line.
- Reduce opportunities for consolidation of adjacent farm fields.

Problems with pole/tower placement can be mitigated to some extent by:

- Using single pole structures.
- Placing the line along fence lines or adjacent to roads, in road ROW.
- Using larger towers with long spans to clear fields.
- Keeping guy wires out of crop lands and placing highly visible shield guards on the guy wires.
- Locating new transmission lines along existing transmission or distribution line corridors.
- Working with farmers to determine optimal tower and pole locations.

Problems with potential soil erosion and compaction can be lessened by avoiding construction and maintenance activities during times when the soil is saturated (during the monsoon). If the ground is damaged then chisel plowing in the compacted areas should be undertaken.

Agriculture in the project area is dominated by three types – subsistence agriculture, dominated by rice paddy, cash crops including tea, oranges, cardamom and jute, and forest including bamboo. The vast majority of the agricultural activities in the region are undertaken by hand or using oxen, and therefore the impacts of transmission towers as physical barriers to turning machinery is likely to be minimal.

If construction activity is undertaken on agricultural land during the growing season then compensation for loss of crops is paid by Power Grid Corporation. The majority of the growing season is during the monsoon which is when groundwater levels are high and dewatering necessary for construction of foundations. Construction under these conditions has potential for more significant impacts, such as increased soil loss and compaction, and is more expensive.

E.1.3 Forests

With sustainable forest management, forests can provide recreational opportunities, wildlife habitat, habitat for rare plants and animals, timber, pulp and ecosystem preservation. Building a major high voltage power line through a primarily forested area, would require clearing of many hectares of trees and shrubs. Depending on where the line is placed, this clearing could cause public (and private) forest devaluation, forest fragmentation, general loss and degradation of woodland habitat, and pulp and timber losses.

Traditionally, forestry defined sustainability as a cutting regime in which a target volume of timber could be maintained indefinitely, that is, sustained yield. The sustainable forestry paradigm has begun to shift away from focusing on trees, or stand level management, to focusing on forest ecosystems and creating and maintaining dynamic landscapes. This shift in view has highlighted forest fragmentation as a complex ecological phenomenon that occurs

when landscapes with large unbroken areas of natural forest are gradually converted to agricultural, urban and commercial uses. Ecologists recognize forest fragmentation as a serious environmental problem. This gradual conversion to other uses fragments or cuts large unbroken forests into increasingly smaller pieces. Development of cleared corridors for infrastructure such as highways, pipelines and power lines can cause forest fragmentation. Eventually, if fragmentation is allowed to continue, a forest will suffer a permanent reduction in its vegetative and wildlife diversity and loose its ability to function as an ecological unit.

The majority of the forested areas are found in the uplands of Darjeeling, Sikkim, Bhutan and Nepal. Any power transmission project within Nepal or Bhutan will almost certainly involve passing through some forested areas. One significant area of forest in the chicken neck is found between Baghdogra and Naksalbari. It is currently unaffected by the existing transmission line corridor. In addition a Forest Reserve at Jaldapara is located 110 km from Siliguri.

E.1.4 Rivers

The type and significance of power line impacts on rivers and streams will vary depending on the characteristics of the water resource. Soil erosion during construction caused by driving vehicles through streams, building temporary bridges, or ROW clearing activities can decrease water quality. Clearing overhanging trees and brush can result in increased water temperatures, reducing habitat quality for fish and other aquatic species. Overhead transmission lines across major rivers and streams may pose a collision hazard for waterfowl and other large birds, especially when located in a migratory corridor. Sand may be extracted from the rivers for construction purposes, particularly for leveling and foundations of the substation.

The project area is subject to the south Asian monsoon which, coupled with the proximity to the Himalayas, gives a distinct seasonality to its rivers. The flat nature of the land away from the mountainous areas means that the rivers are slow moving, wide and meandering. Extended towers might be necessary for rivers to be crossed in a single span.

E.1.5 Topography and Soil

The project area is made up of two contrasting topographic types - the Himalayan foothills and the lowland floodplains. The two areas are subject to different temperatures and hydrological regimes and therefore contain contrasting vegetation and soil types. As the power lines are strung above ground and not buried like a pipeline, impacts upon soils are generally minor. However, soil compaction and disturbance during construction can result in localized impacts on the agricultural quality of soil and increased erosion in rainy season. In mountainous areas mass movement (e.g., landslides) can be a problem, although the foundations are designed to withstand common events. There is seismic activity within the project area, although the Power Grid Corporation has not reported any incidents of collapsing towers.

E.1.5 Flora and Fauna

Transmission lines and towers can provide a danger for birds, however major bird migration routes or feeding areas are not known to exist in the immediate area (there is a bird sanctuary near the Raiganj district 120 km southeast of Siliguri). Some small loses of flora will occur through clearance of the substation footprint and transmission towers, however, as long as the

site locations and transmission route is selected carefully, disturbance of valuable, rare and mature species can be avoided. The Power Grid Corporation have not experienced problems with birds hitting transmission towers. The largest potential impact is in forested areas (see above).

A variety of techniques exist for clearing vegetation from the ROW and controlling the amount and type of new plant growth. From an environmental point of view, selective clearing using mechanical means or herbicides is preferable and should be evaluated in project EIAs. Broadcast aerial spraying of herbicides should be avoided because it affords no selectivity, releases unnecessarily large amounts of chemicals into the environment, and because it is an imprecise application technique, may result in contamination of surface waters and terrestrial food chains, as well as elimination of desirable species and direct poisoning of wildlife.

Currently the Power Grid Corporation physically clear forest areas and canopy within the ROW. They do not use any chemicals.

E.1.7 Archaeological and Cultural Resources

Archaeological artifacts are most valuable if found in place, as their location helps to date them and understand their use. Construction and maintenance of a transmission line, or substation, can damage sites through excavation, crushing by heavy equipment, uprooting of trees, wind or water erosion, and exposing sites to vandals and thieves. Potential impacts can occur whenever the soil is disturbed, including actual pole placement, leveling ground surfaces, and preparing the footprint area of sub stations.

Findings of archaeological resources do not always mean that route changes are necessary. Small changes in tower/pole locations and span length can often avoid sites and artifacts.

Although archaeological sites in the project area were not identified, there are religious sites in the area but these are generally avoidable with careful route planning. Some may even be moved away from the construction sites, as is the case at the new substation at Siliguri where a graveyard (burial ground) has been relocated.

E.1.8 Aesthetics

The overall aesthetic effects of a high-voltage transmission line are likely to be negative to most people, especially for a line that traverses a relatively undeveloped landscape. Many people consider natural resources and power lines to be incompatible. In addition, some may find the scale of the high voltage transmission line inappropriate in some settings. Tall steel structures used for double circuit construction and massive steel lattice corner structures may appear out of proportion with adjacent buildings, fence rows, and forests and therefore seem unsuitable in a particular landscape. Lines constructed using H-frame poles or on wood rather than steel structures may, in some cases, blend better with their surroundings.

There are some people, however, that do not notice transmission lines or do not find them objectionable from an aesthetic perspective. The transmission lines, like roads or water towers, are generally viewed as necessary to sustain everyday lives. To others, new transmission lines may be viewed in a positive light in that they represent economic development. This is quite likely to be the view point in the project region with the area

certainly welcoming any potential economic gains, and the staff of Power Grid Corporation insist that this is the case. Therefore people tend to overlook the visual impacts.

E.1.9 Health and Safety

Placement of low-slung lines or lines near human activity (e.g., highways, buildings) increases the risk for electrocutions. Technical guidelines for design ordinarily minimize this hazard (the ground clearance at the lowest sag point increases with voltage of the line up to a maximum of 7.94m). When working near high-voltage transmission lines, it is important to know that electrical contact can occur, under certain circumstances, even if direct physical contact is not made. In the case of high voltage transmission lines, electricity can arc across an air gap.

An ungrounded metal object (e.g., tractors, fences) under or very near an energized transmission line may become charged with low level AC voltages by an electrostatic induction process. When a person or animal touches the object, a shock may be felt, which is a painful nuisance. Dissipation of such charges occurs when contact is made with the ground. Refueling vehicles directly under a high-voltage transmission line in not a good practice. A spark from discharging a metallic structure with induced voltages to earth could ignite the fuel. The risk of such ignition is higher with gasoline powered vehicles than for diesel fuel powered vehicles.

For protection against lightning transmission lines are usually built with a grounded shield wire at the top of the towers or poles. Typical utility construction practice is to bond the shield wire to ground at each transmission structure or pole. This protects the power line from lightning. Power poles, like trees or other tall objects, may be more likely to intercept nearby lightning strikes, but do not “attract” lightning. Lightning is not more likely to strike houses or cars near a power line. Shorter objects under or very near a line may actually receive some protection form lightning.

The project area, especially in the mountainous region, is subject to lightening strikes and operations have been affected in the past.

Towers and transmission lines can disrupt airplane flight paths in and near airports and endanger low-flying airplanes, especially those used in agricultural management activities (however these are unlikely in the project region). Electric power transmission lines create electromagnetic fields (EMFs). The strengths of both electric and magnetic fields decrease with distance (e.g., meters) from transmission lines. The scientific community has not reached consensus on specific biological responses to EMF, but the evidence suggests that health hazards may exist. Several countries and US states have promulgated rules regulating EMFs associated with high-voltage transmission lines.

E.2 OTHER ISSUES

E.2.1 Noise

Transmission lines can produce noise under certain conditions. Loose hardware or loose connections between the conductors, insulators, and the poles may cause noise in strong winds. In foggy, damp, or rainy conditions power lines can cause a crackling sound as the electricity ionises the moist air near the waves. Ionisation in these conditions can also cause

corona, which is a luminous blue discharge of light, usually where the wires connect to the insulators.

E.2.2 Radio and Television Interference

Power lines do not usually interfere with normal television and radio reception. In some cases, interference is possible at a location close to the ROW due to weak broadcast signals or poor receiving equipment.

E.3 POWERGRID CORPORATION OF INDIA'S APPROACH TO ROUTE SELECTION

While identifying the transmission system for a generation project or as part of the national grid, a preliminary route selection is performed by Powergrid based on the Survey of India topo sheets, Government of India's Forest Atlas, and a walkover survey. During route alignment all possible efforts are made to avoid contact with areas of forest, or minimize contact where geographic or heavy cost issues dominate.

E.3.1 Study of Alternatives

For selection of the optimum route, the following points are taken into consideration:

- The route of the proposed transmission lines does not involve any human rehabilitation.
- Any monument of cultural or historical importance is not affected by the route of the transmission line.
- The proposed route of transmission line does not create any threat to the survival of any community with special reference to Tribal Community.
- The proposed route of transmission line does not affect any public utility services like playgrounds, schools, other establishments, etc..
- The line route does not pass through any sanctuaries, National Parks, etc..
- The line route does not infringe with area of natural resources.
- Powergrid undertakes route selection for individual transmission lines in consultation with representatives from the Ministry of Environmental and Forests and the department of Revenue. Although under National Law Powergrid has the right of eminent domain (Indian Electricity Act 1948, Section 4) alternative alignments are considered keeping in mind the above mentioned factors during site selection, with minor alterations often added to avoid environmentally sensitive areas and settlements.
- As a rule, alignments are situated 10-15 km away from major towns, whenever possible, to account for future urban expansion.
- Similarly, forests are avoided whenever possible, and when it is not possible, a route is selected in consultation with the local Divisional Forest Officer, that causes minimum damage to existing forest resources.
- Alignments are selected to avoid wetlands and unstable areas for both financial and environmental reasons.
- In addition care is also taken to avoid National Parks and sanctuaries and any other forest area rich in wild life.